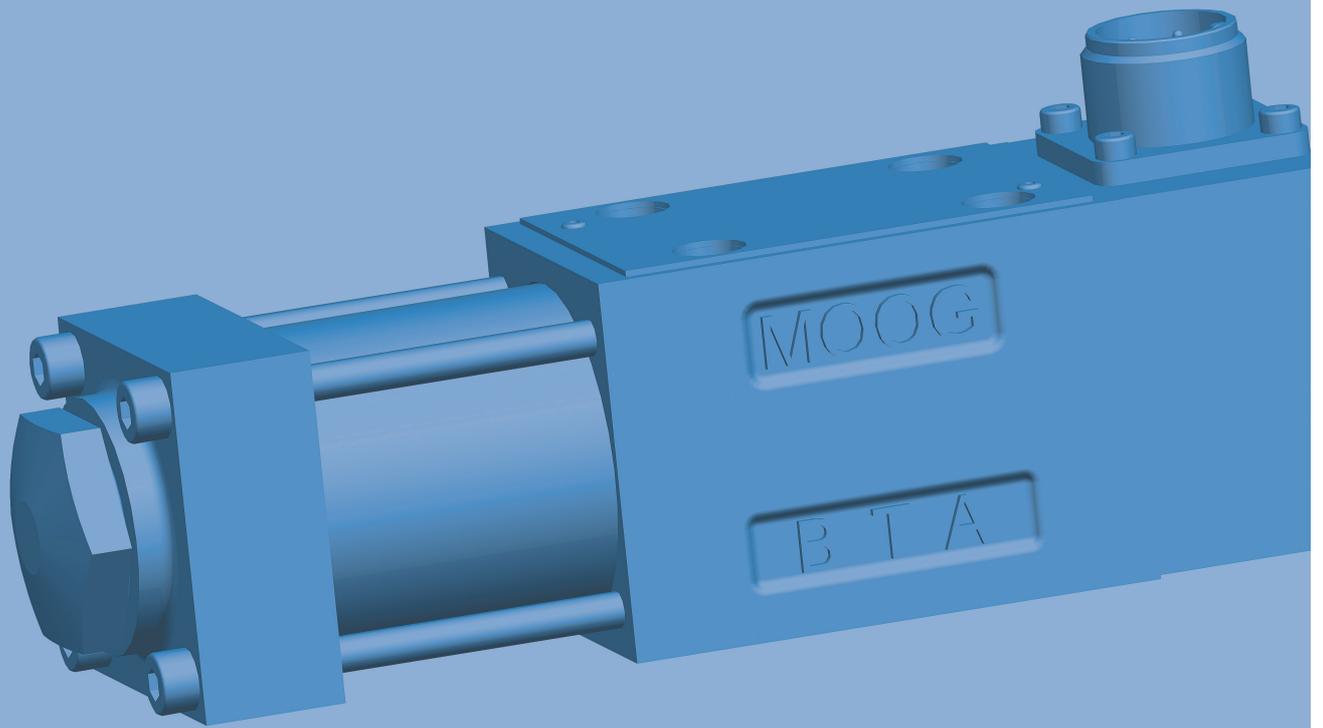


USER MANUAL

D633-A SERIES



DIRECT DRIVE SERVOVALVES SIZE 03 (NG6)

Original User Manual
(CA80942-001; Version 1.0, 12/08)

Copyright

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1 General Information

1.1 Notes on the user manual

This user manual applies only to the standard models of D633-A series valves. It contains the most important information for ensuring proper and correct operation of the valves.

⇒ [Chapter "2.1 Intended operation", page 5](#)

⇒ [Chapter "2.2 Handling in accordance with safety requirements", page 6](#)

 Special models of the valves custom-made for specific customers are not explained in this user manual.

Please contact us or one of our authorized service centers for information on these special models.

The contents of this user manual and the product-related hardware and software documentation relevant to the particular application must be read, understood and followed in all points by each person responsible for machine planning, assembly and operation before work with and on the valves is started. This requirement applies in particular to the safety instructions.

⇒ [Chapter "1.1.2 Completeness", page 1](#)

⇒ [Chapter "2.3 Responsibilities", page 7](#)

⇒ [Chapter "2.4 Selection and qualification of personnel", page 8](#)

⇒ [Chapter "2.2 Handling in accordance with safety requirements", page 6](#)

This user manual has been prepared with great care in compliance with the relevant regulations, state-of-the-art technology and our many years of knowledge and experience. The full contents have been generated to the best of the authors' knowledge.

However, the possibility of error remains and improvements are possible.

Please feel free to submit any comments about possible errors and incomplete information to us.

1.1.1 Validity and subject to change without notice

The information contained in this user manual is valid and correct at the moment of release of this version of the user manual. The version number and release date of this user manual are indicated in the footer.

Changes may be made to this user manual at any time and without reasons being given.

1.1.2 Completeness

This user manual is only complete in conjunction with the product-related hardware and software documentation required for the relevant application.

Available documents:

⇒ [Chapter "1.2 Supplementing documents", page 2](#)

1.1.3 Storage location

This user manual together with all of the product-related hardware and software documentation relevant to the particular application must be kept ready to hand and accessible close to the valve or the higher-level machine at all times.

Notes on the user manual

Validity of the user manual and subject to change without notice

Completeness of the user manual

Storage location for the user manual

1.1.4 Typographical conventions

DANGER



Identifies safety instructions which are intended to warn of immediately imminent danger to life and limb or serious damage to property.
Failure to comply with these safety instructions will inevitably result in fatalities, serious personal injuries (disablement) or serious damage to property!

Typographical conventions

WARNING



Identifies safety instructions which are intended to warn of possible danger to life and limb or possible serious damage to property.
Failure to comply with these safety instructions may result in fatalities, serious personal injuries (disablement) or serious damage to property!

CAUTION



Identifies safety instructions which are intended to warn of minor personal injuries or minor damage to property.
Failure to comply with these safety instructions may result in minor personal injuries or minor damage to property.



Identifies important notes/information

• or –

Identifies listings



Identifies references to another chapter, another page, table or illustration in the user manual

"..."

Identifies headings of chapters or titles of documents, which are referenced

Blue text

Identifies hyperlinks in the PDF file

1., 2., ...

Identifies steps in a procedure which must be performed in consecutive order



Identifies the direction of the valve opening (e.g., P→T)

1.2 Supplementing documents

- The supplementing documents mentioned here are not included in the valves' scope of delivery. They are available as accessories.
⇒ Chapter "13.1 Accessories", page 65

The PDF files of the supplementing documents can be downloaded from the following link:

<http://www.moog.com/Industrial/Literature>

The following supplementing documents are available:

- Application notes "Technical Note TN 353"
Protective grounding and electrical shielding of hydraulic valves with integrated electronics
- Application notes "Technical Note TN 494"
Maximum permissible lengths of electric cables for the connection of hydraulic valves with integrated electronics

Supplementing documents

1.3 Manufacturer's declaration

The valves comply with the standards specified in the associated manufacturer's declaration.

The valves comply with the requirements of the [Machine Directive 98/37/EC](#). Refer to the associated manufacturer's declaration for the applied standards.

- ⓘ Please contact us or one of our authorized service centers for the manufacturer's declaration.

Manufacturer's declaration

1.4 Registered trademarks

Moog and Moog Authentic Repair® are registered trademarks of Moog Inc. and its subsidiaries.

Microsoft® and Windows® are either registered trademarks or trademarks of the Microsoft® Corporation in the USA and/or other countries.

- ⓘ All of the product and company names mentioned in this user manual are possibly registered names or trademarks of the respective manufacturers. The use of these names by third parties for their own purposes may infringe the rights of the manufacturers. The absence of the symbols ® or ™ does not indicate that the name is free from trademark protection.

Registered trademarks

1.5 Warranty and liability

Our General Terms and Conditions of Sale and Payment always apply. These are made available to the buyer at the latest on conclusion of the contract.

Among other things, warranty and liability claims for personal injury and damage to property are excluded if they are caused by one or more of the following:

- Work with and on the valves or handling of the valves by non-qualified personnel
⇒ [Chapter "2.4 Selection and qualification of personnel", page 8](#)
- Non-intended operation
⇒ [Chapter "2.1 Intended operation", page 5](#)
- Handling not in accordance with safety requirements
⇒ [Chapter "2.2 Handling in accordance with safety requirements", page 6](#)
- Omission of the occupational safety and health measures required for the particular application
⇒ [Chapter "2.6 Occupational safety and health", page 9](#)
- Failure to observe this user manual or the product-related hardware and software documentation relevant to the particular application
- Failure to observe the safety standards of the manufacturer and the operator of the machine relevant to the particular application
- Failure to observe the latest versions of the relevant national and international regulations, standards and guidelines (such as e.g., the EU Machinery Directive, the regulations of the trade association and of TÜV or VDE) in the configuration, construction and operation of the machine with all of its installed components
- Omission of suitable safety devices for limiting the pressure at the hydraulic ports
⇒ [Chapter "2.8 Pressure limitation", page 10](#)
- Failure to comply with the preconditions for satisfying the EMC protection requirements
- Use of the valves in a state that is not technically faultless or not operationally safe
- Unauthorized or improperly performed structural modifications, repairs or maintenance
⇒ [Chapter "2.5 Structural modifications", page 8](#)
⇒ [Chapter "11 Service", page 55](#)
- Failure to adhere to the inspection and maintenance instructions of the manufacturer and the operator of machine
- Failure to adhere to all of the technical data relating to the storage, transportation, mounting, removal, connection, start-up, configuration, operation, cleaning, maintenance or elimination of any faults, in particular the ambient conditions and the data pertaining to the hydraulic fluid used
⇒ [Chapter "4 Technical Data", page 25](#)
- Improper storage, transportation, mounting, removal, connection, start-up, configuration, operation, cleaning, maintenance, elimination of any faults or disposal
- Use of unsuitable or defective accessories or of unsuitable or defective spare parts
⇒ [Chapter "13 Accessories and Spare Parts", page 65](#)
- Catastrophes caused by foreign objects or force majeure

Exclusion of warranty and liability

2 Safety

2.1 Intended operation

WARNING

The valves may be operated exclusively within the framework of the data and applications specified in the user manual.

Any other or more extensive use is not permitted.

Intended operation

WARNING

Use of the valves in potentially explosive environments is not permitted.

The valves may only be operated as a component part of a higher-level overall system, for example in a machine.

They may be used only as control elements to control flow and/or pressure in hydraulic circuits that regulate position, speed, pressure and power.

The valves are intended for use with mineral-oil-based hydraulic oils. Use with other media requires our prior approval.

Correct, reliable and safe operation of the valves requires qualified project planning as well as proper utilization, transportation, storage, mounting, removal, electrical and hydraulic connection, start-up, configuration, operation, cleaning and maintenance.

The valves may only be started up when the following is ensured:

- The higher-level machine with all of its installed components complies with the latest versions of the relevant national and international regulations, standards and guidelines (such as e.g., the EU Machinery Directive, the regulations of the trade association and of TÜV or VDE).
- The valves and all of the other installed components are in a technically fault-free and operationally reliable state.
- No signals which can lead to uncontrolled movements in the machine are transmitted to the valves.

Intended operation also includes the following:

- Observation of this user manual
- Handling of the valves in accordance with safety requirements
⇒ [Chapter "2.2 Handling in accordance with safety requirements", page 6](#)
- Adherence to all of the inspection and maintenance instructions of the manufacturer and the operator of the machine
- Observation of all product-related hardware and software documentation relevant to the particular application
- Observation of all safety standards of the manufacturer and the operator of the machine relevant to the particular application
- Observation of all the latest versions of the national and international regulations, standards and guidelines relevant to the particular application (such as e.g., the EU Machinery Directive, the regulations of the trade association and of TÜV or VDE)

2.2 Handling in accordance with safety requirements

WARNING

It is the responsibility of the manufacturer and the operator of the machine to ensure that the valves are handled in accordance with safety requirements.

WARNING

As in any electronic control system, the failure of certain components in valves as well might lead to an uncontrolled and/or unpredictable operational sequence. All types of failure on a system level must be taken into consideration and appropriate protective measures must be taken.

The use of automatic control technology in a machine calls for special measures.

If automatic control technology is to be used, the user should, in addition to all of the potentially available standards or guidelines on safety-engineering installations, consult the manufacturers of the components used in great depth.

In order to ensure that the valves are handled in accordance with safety requirements and operated without faults, it is essential to observe the following:

- All of the safety instructions in the user manual
- All of the safety instructions in the product-related hardware and software documentation relevant to the particular application
- All of the safety instructions in the safety standards of the manufacturer and the operator of the machine relevant to the particular application
- All of the relevant national and international safety and accident prevention regulations, standards and guidelines, such as e.g., the safety regulations of the trade association, of TÜV or VDE, in particular the following standards pertaining to the safety of machinery:
 - [DIN EN ISO 12100](#)
 - [DIN EN 982](#)
 - [DIN EN 563](#)
 - [EN 60204](#)

Handling in accordance with safety requirements

Observing the safety instructions and the safety and accident prevention regulations, standards and guidelines will help to prevent accidents, malfunctions and damage to property!

2.3 Responsibilities

The manufacturer and the operator of the machine are responsible for ensuring that work with and on the valves and handling of the valves is planned and performed in accordance with the directions given in this user manual and in the product-related hardware and software documentation relevant to the particular application.

The manufacturer and the operator of the machine are in particular responsible for ensuring the following:

- Selection and training of personnel
⇒ Chapter "2.4 Selection and qualification of personnel", page 8
- Intended operation
⇒ Chapter "2.1 Intended operation", page 5
- Handling in accordance with safety requirements
⇒ Chapter "2.2 Handling in accordance with safety requirements", page 6
- Taking and monitoring of the occupational safety and health measures required for the particular application
⇒ Chapter "2.6 Occupational safety and health", page 9
- Observation of all of the safety standards of the manufacturer and the operator of the machine relevant to the particular application
- Observation of the latest versions of the relevant national and international regulations, standards and guidelines (such as e.g., the EU Machinery Directive, the regulations of the trade association and of TÜV or VDE) in the configuration, construction and operation of the machine with all of its installed components
- Installation of suitable safety devices for limiting the pressure at the hydraulic ports
⇒ Chapter "2.8 Pressure limitation", page 10
- Compliance with the preconditions for satisfying the EMC protection requirements
- Use of the valves in a technically faultless and operationally safe state
- Prevention of unauthorized or improperly performed structural modifications, repairs or maintenance
⇒ Chapter "2.5 Structural modifications", page 8
⇒ Chapter "11 Service", page 55
- Definition and observation of the application-specific inspection and maintenance instructions
- Adherence to all of the technical data relating to the storage, transportation, mounting, removal, connection, start-up, configuration, operation, cleaning, maintenance or elimination of any faults, in particular the ambient conditions and the data pertaining to the hydraulic fluid used
⇒ Chapter "4 Technical Data", page 25
- Proper storage, transportation, mounting, removal, connection, start-up, configuration, operation, cleaning, maintenance, elimination of any faults or disposal
- Use of suitable and faultless accessories and of suitable and faultless spare parts
⇒ Chapter "13 Accessories and Spare Parts", page 65
- Handy and accessible storage of this user manual and of the product-related hardware and software documentation relevant to the particular application
⇒ Chapter "1.1.3 Storage location", page 1

Responsibility of the manufacturer and the operator of the machine

2.4 Selection and qualification of personnel

WARNING

Only properly qualified and authorized users may work with and on the valves.

Selection and qualification of personnel

Qualified users are specialized personnel with the required knowledge and experience who have been trained to carry out such work. The specialized personnel must be able to recognize and avert the dangers which they are exposed to when working with and on the valves.

Qualified users

In particular, these specialized personnel must be authorized to operate, earth/ground and mark hydraulic and electrical devices, systems and power circuits in accordance with the standards of safety engineering. Project planners must be fully conversant with automation safety concepts.

Warranty and liability claims for personal injury or damage to property are among others excluded if such injury or damage is caused when the valves are worked on or handled by non-qualified personnel.

⇒ [Chapter "1.5 Warranty and liability", page 4](#)

2.5 Structural modifications

WARNING

In the interests of avoiding damage to the valves or accessories, structural modifications, on account of the complexity of the internal components of the valves or accessories, may only be carried out by us or one of our authorized service centers.

Structural modifications

Warranty and liability claims for personal injury and damage to property are among others excluded if they are caused by unauthorized or improperly performed structural modifications or other interventions.

⇒ [Chapter "1.5 Warranty and liability", page 4](#)

2.6 Occupational safety and health

WARNING



The magnets in the permanent magnet linear force motor create strong magnetic fields, which can have a disruptive effect on sensitive devices, such as e.g., cardiac pacemakers. The relevant safe distances appropriate for the device must be observed.

Occupational safety and health measures and equipment

CAUTION



Depending on the application, significant levels of noise may be generated when the valves are operated. If necessary, the manufacturer and operator of the machine must take appropriate sound insulation measures or stipulate that suitable safety equipment, such as e.g., ear protection, be worn.

CAUTION



Falling objects, such as e.g., valve, tool or accessory, can cause injury. Suitable safety equipment, such as e.g., safety shoes, must be worn to provide protection against injury.

CAUTION



Valves and hydraulic port lines can become very hot during operation. Suitable safety equipment, such as e.g., work gloves, must be worn to provide protection against injury before touching the valve or the connection cables during such operations as mounting, removal, electrical and hydraulic connection, troubleshooting or servicing.

CAUTION



When handling hydraulic fluids, observe the safety provisions applicable to the hydraulic fluid used. If necessary, suitable safety equipment, such as e.g., work gloves, must be worn.

2.7 General safety instructions

WARNING



Only properly qualified and authorized users may work with and on the valves.

⇒ Chapter "2.4 Selection and qualification of personnel", page 8

General safety instructions

WARNING



Observe and adhere to the technical data and in particular the information given on the valve nameplate.

⇒ Chapter "4 Technical Data", page 25

CAUTION



This user manual and the product-related hardware and software documentation relevant to the particular application must be inserted in the machine's operating instructions.

2.8 Pressure limitation

WARNING

Excessive pressure at the hydraulic ports damages the valve and can cause unsafe states in the machine and personal injury.

Pressure-limiting valves, for example, or other comparable safety devices must be installed to limit the pressure at all of the hydraulic ports to the specified maximum operating pressure.

Maximum operating pressure:

⇒ [Chapter "4 Technical Data", page 25](#)

Safety devices for pressure limitation

3 Product Description

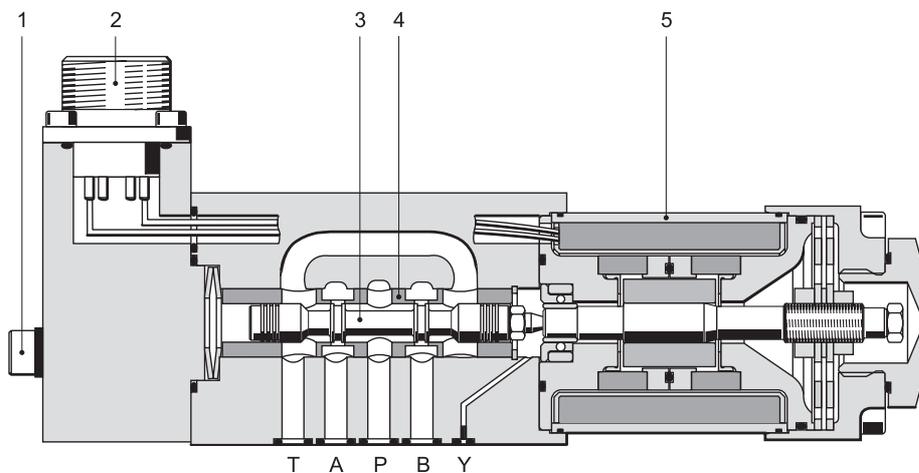
3.1 Function and mode of operation

The valves of the D633-A series are direct drive servovalves (DDV: **D**irect **D**rive **V**alve). The valves are throttle valves for 2-, 3-, 4- or even 2x2-way applications.

They are suitable for electrohydraulic position, speed, pressure and force control even for high dynamic requirements. They control flow.

Function of the valves:
throttle valves

3.1.1 Representative depiction of the valve



Representative depiction
of the valve

Item	Designation	Further information
1	Grounding screw	⇒ Chapter "8.3 Grounding screw", page 44
2	Valve connector X1	⇒ Chapter "8.2 Valve connector X1", page 43
3	Spool	
4	Bushing	
5	Permanent magnet linear force motor	⇒ Chapter "3.1.2 Permanent magnet linear force motor", page 12
T...Y	Ports	⇒ Chapter "7.2.2 Mounting pattern of mounting surface", page 37

Figure 1: Representative depiction of a direct drive servovalve

3.1.2 Permanent magnet linear force motor

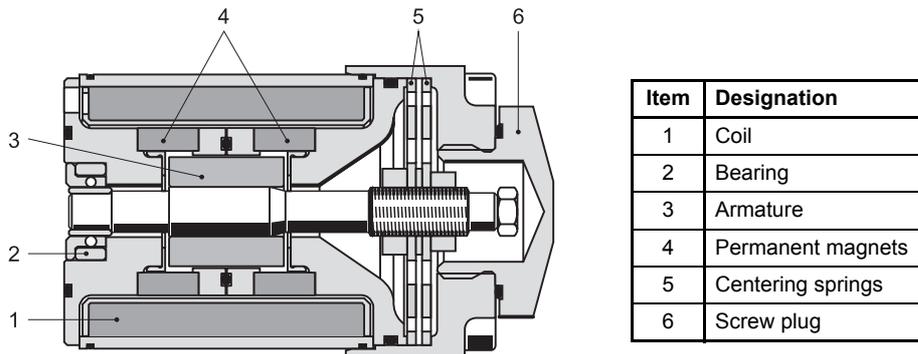


Figure 2: Representative depiction of a permanent magnet linear force motor

Representative depiction of a permanent magnet linear force motor

A permanent magnet linear force motor (figure 2 or item 10 in figure 1) is used to drive the valve spool (item 8 in figure 1).

In contrast to proportional-solenoid drives, the permanent magnet linear force motor can move the spool from the spring-centered center position in both working directions. This results in high actuating power for the spool simultaneously with very good static and dynamic properties.

The permanent magnet linear force motor is a differential motor excited by permanent magnets. Some of the magnetic force is already provided by the permanent magnets. The linear force motor's power demand is thus significantly lower than is the case with comparable proportional solenoids.

The linear force motor (figure 2 or item 10 in figure 1) drives the valve spool (item 8 in figure 1). The spool starting position is determined in the de-energized state by the centering springs (item 5 in figure 2). The linear force motor enables the spool to be displaced from the starting position in both directions. Here, the actuating power of the linear force motor is proportional to the coil current.

The high forces of the linear force motor and centering springs effect precise spool movement even against flow and frictional forces.

Permanent magnet linear force motor

3.1.3 Signal interfaces

The valves are provided with a valve connector X1 for the command signal.

Pin assignment of valve connector X1:

⇒ [Chapter "8.2 Valve connector X1", page 43](#)

3.2 Safety function/fail-safe

WARNING



It is essential to observe the notes/information on handling in accordance with safety requirements particularly in the case of safety-critical applications.

⇒ Chapter "2.2 Handling in accordance with safety requirements", page 6

WARNING



The manufacturer and the operator of the machine are responsible for ensuring that, when the machine is configured, designed and operated with all of the installed components, the latest version of the safety standards relevant to safety-critical applications applicable to averting damage are observed.

It is vital among other things to ensure that both the individual components and the complete machine can be rendered in a safe state.

The mechanical valve fail-safe functions increase the safety of the user if the command signal fails.

⇒ Chapter "3.2.1 Mechanical fail-safe functions", page 13

The valve is rendered in the mechanical fail-safe state if the command signal fails. The mechanical valve fail-safe state is denoted by the fact that the spool is in a defined spring-determined position.

⇒ Chapter "3.2.1.2 Mechanical fail-safe state", page 14

It is essential to ensure at the machine end that the fail-safe state results in a safe state in the machine.

The valve must be restarted after its transition into the fail-safe state.

⇒ Chapter "3.2.2 Restarting the valve", page 15

Mechanical fail-safe functions

Mechanical fail-safe state

3.2.1 Mechanical fail-safe functions

The following mechanical fail-safe functions are available:

- Fail-safe function F
- Fail-safe function D
- Fail-safe function M

i It is necessary when ordering the valve to establish which mechanical fail-safe function is to be integrated in the valve.

Which mechanical fail-safe function is integrated in the valve can be ascertained from the fail-safe identification, i.e., the 6th position in the valve type designation.

⇒ Chapter "3.2.1.3 Fail-safe identification", page 14

Mechanical fail-safe functions

3.2.1.1 Valves with fail-safe function F, D or M

In the case of the fail-safe functions F, D and M, the mechanical setting of the linear force motor or corresponding centering springs at the factory establishes which position the spool assumes in the mechanical fail-safe state.

Position of spool: ⇒ [Table 1, page 14](#)

**Fail-safe functions
F, D and M**

3.2.1.2 Mechanical fail-safe state

The valve is in the mechanical fail-safe state when the spool is in a defined spring-determined position.

Fail-safe function	Position of spool
F	Defined position of spool: approx. 10 % valve opening: P→B and A→T
D	Defined position of spool: approx. 10 % valve opening: P→A and B→T
M	Defined overlapped center position of spool The mechanical fail-safe function M gives rise only in conjunction with spools which have an overlap greater than ±10 %, i.e., in valves with bushing-spool identification D, to the defined overlapped center position. In the case of a smaller overlap, i.e., in valves with a different bushing-spool identification, a defined overlapped center position is not possible. ⇒ Chapter "3.2.1.4 Bushing-spool identification", page 15

**Position of the spool in
the mechanical fail-safe
state**

Table 1: Position of the spool in the mechanical valve fail-safe state

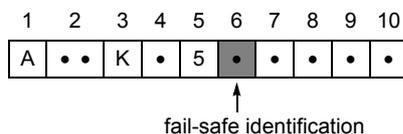
3.2.1.3 Fail-safe identification

The fail-safe identification, i.e., the 6th position in the valve type designation, indicates which mechanical fail-safe function is integrated in the valve.

Overview of type designation: ⇒ [Chapter "3.5 Nameplate", page 18](#)

**Fail-safe identification
(6th position in type
designation)**

Type designation:



Ident.	Fail-safe function	Further information
F	Valves with fail-safe function F	⇒ Table 1, page 14
D	Valves with fail-safe function D	⇒ Chapter "3.2.1.1 Valves with fail-safe function F, D or M", page 14
M	Valves with fail-safe function M	
X	Valves with special fail-safe function	

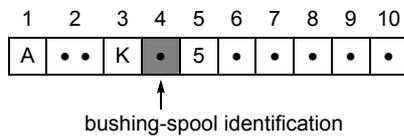
Table 2: Fail-safe identification in the type designation

3.2.1.4 Bushing-spool identification

The bushing-spool identification, i.e., the 4th position in the valve type designation, indicates which bushing-spool version is integrated in the valve.

Overview of type designation: ⇒ [Chapter "3.5 Nameplate", page 18](#)

Type designation:



Ident.	Valve configuration	Bushing-spool version
O	4-way	Linear characteristic curve, zero lap
A	4-way	Linear characteristic curve, ±1.5 % to ±3 % positive overlap
D	4-way	Linear characteristic curve, ±10 % positive overlap
B	3-way	Valve opening: P→A and A→T
Z	2x2-way	Valve opening: P→A and B→T (externally connect P with B and A with T), with port Y only
X		Special spool, on request

Table 3: Bushing-spool identification in the type designation

Bushing-spool identification
(4th position in type designation)

3.2.2 Restarting the valve

WARNING



Before restarting the valve after the transition of the valve into the fail-safe state, it is necessary to identify and if necessary rectify the cause of the fault at the machine end.

It is also necessary to ensure that restarting the valve does not give rise to unintentional or dangerous states in the machine.

Restarting the valve

After shutdown/failure of the command signal:

After the transition of the valve into the fail-safe state on account of a shutdown/failure of the command signal to the valve, it will be necessary to restart the valve by applying the command signal in accordance with the technical data.

3.3 Hydraulics

3.3.1 Open-loop flow control (Q-control)

WARNING



To ensure faultless valve operation, it is necessary to configure the valve correctly with regard to flow and pressure.

The valves are operated as open-loop flow control valves.

In open-loop flow control an open-loop control of the spool position is carried out. The predefined command signal corresponds to a particular spool position. The flow that is set depends not only on the spool position but also on the pressure difference Δp at the individual control lands.

⇒ Chapter "5.1 Dependency of Flow and Pressure Drop", page 29

⇒ Chapter "5.2 Flow signal characteristic curve", page 29

Operational mode:

Open-loop flow control (Q-control)

3.3.2 Valve configurations and hydraulic symbols

Depending on the model, the following valve configurations are possible:

- 2-way operation
⇒ Chapter "3.3.2.2 2-way and 2x2-way operation", page 17
- 3-way operation
⇒ Chapter "3.3.2.1 4-way and 3-way operation", page 16
- 4-way operation
⇒ Chapter "3.3.2.1 4-way and 3-way operation", page 16
- 2x2-way operation
⇒ Chapter "3.3.2.2 2-way and 2x2-way operation", page 17

Valve configurations

3.3.2.1 4-way and 3-way operation

With 4-way operation the valves can be used to control the flow in ports A and B (used as throttle valves).

4-way and 3-way operation

Port A or B must be blocked in order to obtain 3-way operation.

Leakage port Y must be used if the pressure in tank port T exceeds a value of 50 bar (725 psi).

⇒ Chapter "3.3.3 Leakage port Y", page 17

The valves are available with zero lap, less than $\pm 3\%$ or $\pm 10\%$ positive overlap.

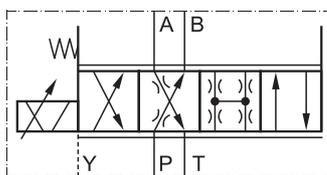


Figure 3: 4-way operation with mechanical fail-safe function F (hydraulic symbol)

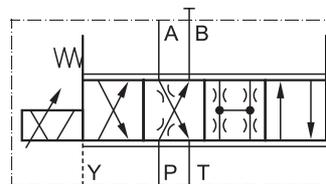


Figure 4: 3-way operation with mechanical fail-safe function F (hydraulic symbol)

Hydraulic symbols: 4-way and 3-way operation

⇒ Chapter "3.2.1.1 Valves with fail-safe function F, D or M", page 14

3.3.2.2 2-way and 2x2-way operation

With 2-way and 2x2-way operation the valves can be used to control the flow in one direction (used as throttle valves).

2-way and 2x2-way operation

With 2x2-way operation the valve can be used in 2-way applications for greater flows.

Ports P with B and A with T must be externally connected for this purpose.

The direction of flow must be observed as per [figure 6](#).

- ❗ Leakage port Y must always be connected with 2x2-way operation.
⇒ [Chapter "3.3.3 Leakage port Y", page 17](#)

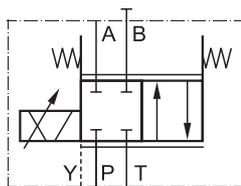


Figure 5: 2-way operation with mechanical fail-safe function M (hydraulic symbol)

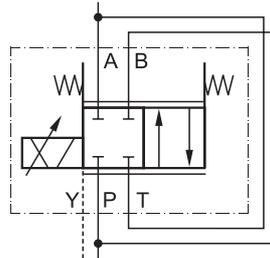


Figure 6: 2x2-way operation with mechanical fail-safe function M (hydraulic symbol)

⇒ [Chapter "3.2.1.1 Valves with fail-safe function F, D or M", page 14](#)

3.3.3 Leakage port Y

Leakage port Y must be used in the following cases:

Leakage port Y

- when the pressure p_T in tank port T is greater than 50 bar (725 psi)
- with 2x2-way operation

- ❗ The valve can be supplied either with or without leakage port Y. It is necessary when ordering the valve to establish whether leakage port Y is to be used. Whether leakage port Y is used can be ascertained from the Y-identification, i.e., the 7th position in the type designation.
⇒ [Chapter "3.3.3.1 Y-identification", page 17](#)

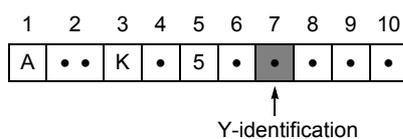
3.3.3.1 Y-identification

The Y-identification, i.e., the 7th position in the valve type designation, indicates how leakage port Y is configured in the valve.

Y-identification (7th position in type designation)

Overview of type designation: ⇒ [Chapter "3.5 Nameplate", page 18](#)

Type designation:



Ident.	Leakage port Y	Can be used at
0	Closed, with screw plug	Pressure in tank port $p_T \leq 50$ bar (725 psi)
3	Open, with filter element	Pressure in tank port $p_T > 50$ bar (725 psi)

Table 4: Y-identification in the type designation

3.4 Activation

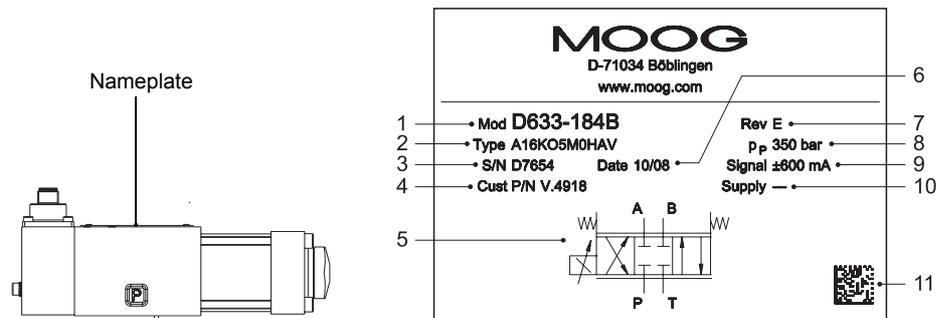
The valves are controlled with a command signal via the valve connector X1.

⇒ Chapter "3.1.3 Signal interfaces", page 12

⇒ Chapter "3.5.2.10 Command signal identification", page 23

Activation of the valves

3.5 Nameplate



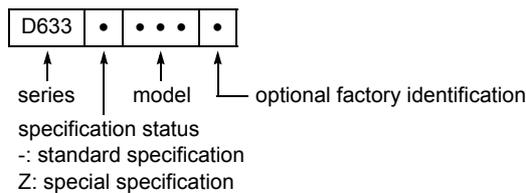
Nameplate

Item	Designation	Further information
1	Model number	⇒ Chapter "3.5.1 Model number", page 18
2	Type designation	⇒ Chapter "3.5.2 Type Designation", page 19
3	Serial number	
4	Optional customer-specific designation	
5	Hydraulic symbol	
6	Date of manufacture in MM/YY format	
7	Optional version identification	
8	Maximum operating pressure	⇒ Chapter "4.2 Hydraulic data", page 26
9	Command signal	⇒ Chapter "3.5.2.10 Command signal identification", page 23
10	Supply	No additional supply voltage necessary. The valves are controlled with a command signal via the valve connector X1. Pin assignment of valve connector X1: ⇒ Chapter "8.2 Valve connector X1", page 43
11	Data matrix code	⇒ Chapter "3.5.3 Data matrix code", page 23

Figure 7: Nameplate (example)

3.5.1 Model number

The model number is set out as follows:



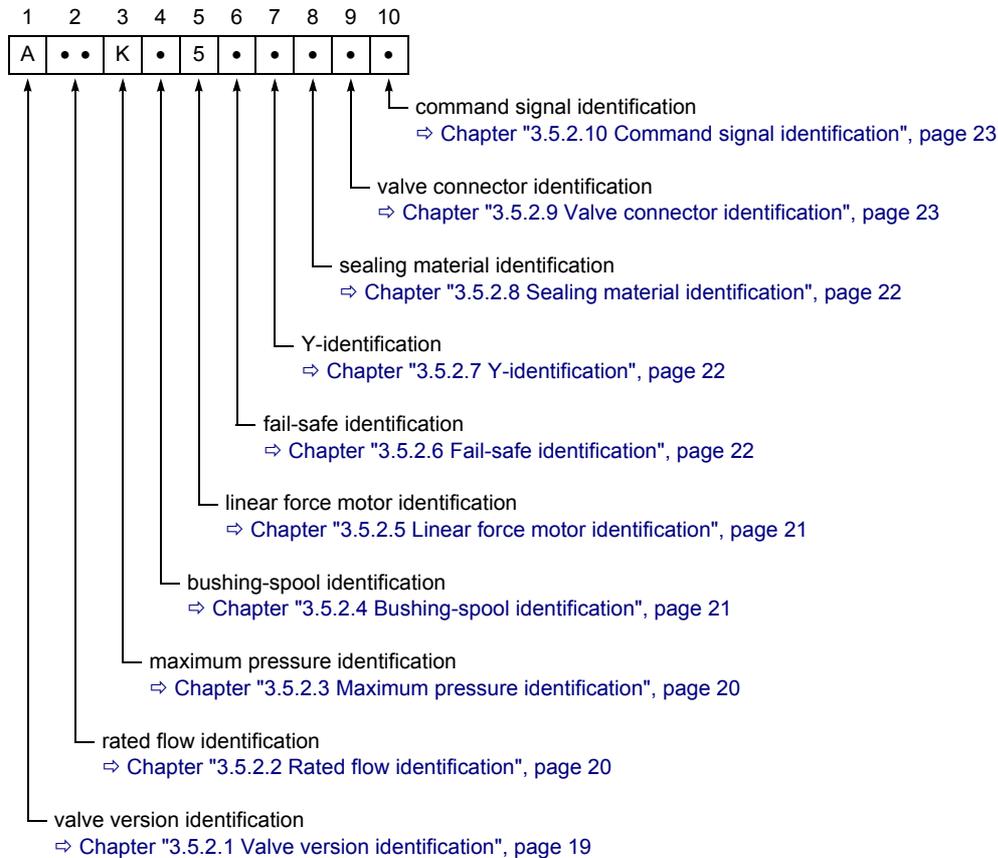
Example: D633-184B

Model number

3.5.2 Type Designation

The valve type designation is set out as follows:

Type Designation



i The 2nd position of the valve type designation consists of two characters.

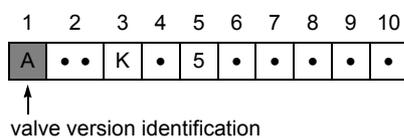
3.5.2.1 Valve version identification

The valve version identification, i.e., the 1st position in the valve type designation, indicates the version of the valve.

Overview of type designation: ⇒ Chapter "3.5 Nameplate", page 18

Valve version identification
 (1st position in type designation)

Type designation:



Ident.	Valve version
A	Servovalve (DDV) with bushing-spool assembly, without integrated electronics

Table 5: Valve version identification in the type designation

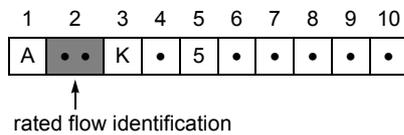
3.5.2.2 Rated flow identification

The rated flow identification, i.e., the 2nd position in the valve type designation, indicates the rated flow of the valve.

Overview of type designation: ⇒ [Chapter "3.5 Nameplate", page 18](#)

Rated flow identification
(2nd position in type designation)

Type designation:



Ident.	Rated flow Q_N at	
	$\Delta p_N = 35 \text{ bar (508 psi)}$	$\Delta p_N = 5 \text{ bar (72.5 psi)}$
02	5 l/min (1.3 gpm)	2 l/min (0.53 gpm)
04	10 l/min (2.6 gpm)	4 l/min (1.0 gpm)
08	20 l/min (5.3 gpm)	8 l/min (2.1 gpm)
16	40 l/min (10.5 gpm)	16 l/min (4.2 gpm)

Table 6: Rated flow identification in the type designation

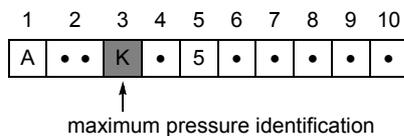
3.5.2.3 Maximum pressure identification

The maximum pressure identification, i.e., the 3rd position in the valve type designation, indicates what maximum operating pressure is permissible.

Overview of type designation: ⇒ [Chapter "3.5 Nameplate", page 18](#)

Maximum pressure identification
(3rd position in type designation)

Type designation:



Ident.	Maximum operating pressure
K	350 bar (5,075 psi)

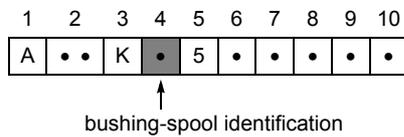
Table 7: Maximum pressure identification in the type designation

3.5.2.4 Bushing-spool identification

The bushing-spool identification, i.e., the 4th position in the valve type designation, indicates which bushing-spool version is integrated in the valve.

Overview of type designation: ⇒ [Chapter "3.5 Nameplate", page 18](#)

Type designation:



Ident.	Valve configuration	Bushing-spool version
O	4-way	Linear characteristic curve, zero lap
A	4-way	Linear characteristic curve, ±1.5 % to ±3 % positive overlap
D	4-way	Linear characteristic curve, ±10 % positive overlap
B	3-way	Valve opening: P→A and A→T
Z	2x2-way	Valve opening: P→A and B→T (externally connect P with B and A with T), with port Y only
X		Special spool, on request

Table 8: Bushing-spool identification in the type designation

Bushing-spool identification

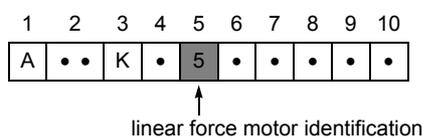
(4th position in type designation)

3.5.2.5 Linear force motor identification

The linear force motor identification, i.e., the 5th position in the valve type designation, indicates which linear force motor is integrated in the valve.

Overview of type designation: ⇒ [Chapter "3.5 Nameplate", page 18](#)

Type designation:



Ident.	Integrated linear force motor
5	Standard linear force motor

Table 9: Linear force motor identification in the type designation

Linear force motor identification

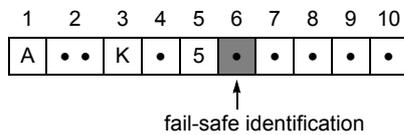
(5th position in type designation)

3.5.2.6 Fail-safe identification

The fail-safe identification, i.e., the 6th position in the valve type designation, indicates which mechanical fail-safe function is integrated in the valve.
Overview of type designation: ⇒ [Chapter "3.5 Nameplate", page 18](#)

Fail-safe identification
(6th position in type designation)

Type designation:



Ident.	Fail-safe function	Further information
F	Valves with fail-safe function F	⇒ Table 1, page 14 ⇒ Chapter "3.2.1.1 Valves with fail-safe function F, D or M", page 14
D	Valves with fail-safe function D	
M	Valves with fail-safe function M	
X	Valves with special fail-safe function	

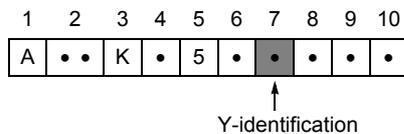
Table 10: Fail-safe identification in the type designation

3.5.2.7 Y-identification

The Y-identification, i.e., the 7th position in the valve type designation, indicates how leakage port Y is configured in the valve.
Overview of type designation: ⇒ [Chapter "3.5 Nameplate", page 18](#)

Y-identification
(7th position in type designation)

Type designation:



Ident.	Leakage port Y	Can be used at
0	Closed, with screw plug	Pressure in tank port $p_T \leq 50$ bar (725 psi)
3	Open, with filter element	Pressure in tank port $p_T > 50$ bar (725 psi)

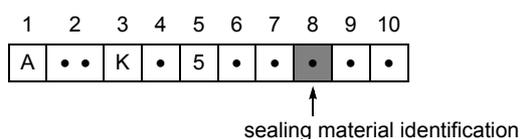
Table 11: Y-identification in the type designation

3.5.2.8 Sealing material identification

The sealing material identification, i.e., the 8th position in the valve type designation, indicates the sealing material of the port O-rings of the valve.
Overview of type designation: ⇒ [Chapter "3.5 Nameplate", page 18](#)

Sealing material identification
(8th position in type designation)

Type designation:



Ident.	Sealing material
H	HNBR
V	FKM
E	EPDM

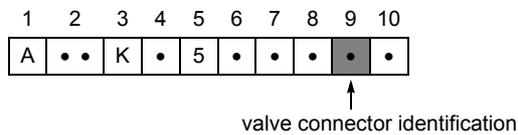
Table 12: Sealing material identification in the type designation

3.5.2.9 Valve connector identification

The valve connector identification, i.e., the 9th position in the valve type designation, indicates which valve connector is installed to the valve.

Overview of type designation: ⇒ [Chapter "3.5 Nameplate", page 18](#)

Type designation:



Ident.	Valve connector
A	4-pin MIL connector as per MIL-DTL-5015/14S-2P
M	4-pin M12 connector as per IEC 60947-4-2

Table 13: Valve version identification in the type designation

Valve version identification

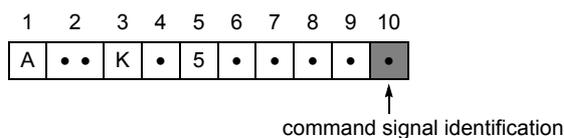
(9th position in type designation)

3.5.2.10 Command signal identification

The command signal identification, i.e., the 10th position in the valve type designation, indicates the command signal of the valve.

Overview of type designation: ⇒ [Chapter "3.5 Nameplate", page 18](#)

Type designation:



Ident.	Command signal
V	$I_{in} = \pm 600 \text{ mA}$
Y	Special command signal for valves with fail-safe function F and D, on request

Table 14: Command signal identification in the type designation

Command signal identification

(10th position in type designation)

3.5.3 Data matrix code

The data matrix code is a two-dimensional code. The code on the nameplate contains a character string which is set out as follows:

model number	#	optional version identification	#	serial number with country identification
--------------	---	---------------------------------	---	---

⇒ [Chapter "3.5.1 Model number", page 18](#)

⇒ [Figure 7, page 18, item 7](#)

⇒ [Figure 7, page 18, item 3](#)

If there is no optional version identification, a blank space appears here.

Example: D633-184B#E#D7654

Data matrix code

For your notes.

4 Technical Data

WARNING Observe and adhere to the technical data and in particular the information given on the valve nameplate.



4.1 General technical data

WARNING Use of the valves in potentially explosive environments is not permitted.



CAUTION The valves must not be immersed in liquids!



Version	Servovalve		
Mass	Approx. 2.5 kg (5.5 lb)		
Dimensions	⇒ Chapter "7.1 Dimensions (installation drawings)", page 36		
Installation position	In any position, fixed or moving  Observe the relevant safety instructions when mounting the valve. ⇒ Chapter "7 Mounting and Connection to the Hydraulic System", page 35		
Permissible ambient conditions	Ambient temperature		
	For transportation/storage	Recommended	15 °C to 25 °C (59 to 77 °F) ¹
		Permissible	−40 °C to 80 °C (−40 to 176 °F) ¹
	For operation	−20 °C to 80 °C (−4 to 176 °F)	
	Rel. air humidity for storage	< 65 % not condensing	
	Vibration resistance ²	30 g, 3 axes, frequency: 10 to 2000 Hz (as per DIN EN 60068-2-6)	
Shock resistance ²	50 g, 6 directions, half-sine 3 ms (as per DIN EN 60068-2-27)		

General technical data

Table 15: General technical data

¹ Temperature fluctuations > 10 °C (50 °F) must be avoided during storage.

² Transportation and storage should be as vibration- and shock-free as possible.

4.2 Hydraulic data

Valve construction type	Spool valve, one-stage, with bushing		
Actuation	Directly with permanent magnet linear force motor		
Control oil supply	None		
Nominal size and mounting pattern	NG6, mounting pattern as per ISO 4401-03-03-0-05, with or without leakage port Y ⇒ Chapter "3.3.3 Leakage port Y", page 17 ⇒ Chapter "7.2.2 Mounting pattern of mounting surface", page 37		
Diameter of ports	7.9 mm (0.31 in) ⇒ Chapter "7.2.2 Mounting pattern of mounting surface", page 37		
Sealing material	HNBR, FKM, EPDM, others on request ⇒ Chapter "3.5.2.8 Sealing material identification", page 22		
Valve configurations	2-way, 3-way, 4-way and 2x2-way operation ⇒ Chapter "3.3.2 Valve configurations and hydraulic symbols", page 16		
Overlap	Zero lap, less than ±3 % or ±10 % positive overlap (model-dependent) ⇒ Chapter "3.5.2.4 Bushing-spool identification", page 21		
Max. flow Q_{max}	75 l/min (20 gpm) ⇒ Chapter "5.1 Dependency of Flow and Pressure Drop", page 29		
Rated flow Q_N	5/10/20/40 l/min (1.3/2.6/5.3/10.5 gpm) (model-dependent) (at $\Delta p_N = 35$ bar (508 psi) per control land: tolerance ±10 %) ⇒ Chapter "3.5.2.2 Rated flow identification", page 20		
Max. leakage flow Q_L^1	0.15/0.3/0.6/1.2 l/min (0.04/0.08/0.16/0.32 gpm) (model-dependent)		
Maximum operating pressure	Ports P, A and B	350 bar (5,075 psi) ⇒ Chapter "3.5.2.3 Maximum pressure identification", page 20	
	Port T without Y	50 bar (725 psi) ⇒ Chapter "3.3.3 Leakage port Y", page 17	
	Port T with Y	350 bar (5,075 psi)	
	Port Y	Depressurized to tank	
Hydraulic fluid	Permissible fluids	Mineral-oil-based hydraulic oil as per DIN 51524-1 to DIN 51524-3 Other fluids on request	
	Permissible temperature	-20 to 80 °C (-4 to 176 °F)	
	Viscosity ν	Recommended	15 to 100 mm ² /s
		Permissible	5 to 400 mm ² /s
	Cleanliness level, recommended (ISO 4406)	For functional safety	< 18/15/12
		For life cycle (wear and tear)	< 17/14/11
 The cleanliness of the hydraulic fluid greatly influences the functional safety (safe positioning of the spool, high resolution) and the wear (control lands, pressure gain, leakage losses) of the valves. To avoid malfunctions and increased wear, we recommend that the hydraulic fluid be filtered accordingly.			

Table 16: Hydraulic data

¹ Typical values (measured at operating pressure $p_p = 140$ bar (2,030 psi), viscosity of hydraulic fluid $\nu = 32$ mm²/s and temperature of hydraulic fluid $T = 40$ °C (104 °F))

4.3 Static and dynamic data

Step response time for 0 to 100 % spool stroke ¹	18 ms ⇒ Chapter "5.5 Step response and frequency response", page 31
Hysteresis ¹	Approx. 10 %

Table 17: Static and dynamic data

¹ Typical values (measured at operating pressure $p_p = 140$ bar (2,030 psi), viscosity of hydraulic fluid $\nu = 32$ mm²/s and temperature of hydraulic fluid $T = 40$ °C (104 °F))

4.4 Electrical data

Protection type	IP65 with mounted mating connectors (as per DIN EN 60529)
Command signal	$I_{in} = \pm 600 \text{ mA}$
External fuse protection for each valve	1.6 A slow-blowing fuse
Duty cycle	100 %
Valve connector X1	4-pin M12 connector with pin contacts (as per IEC 60947-4-2) or 4-pin MIL connector with pin contacts (as per MIL-DTL-5015/14S-2P) ⇒ Chapter "8.2 Valve connector X1", page 43 ⇒ Chapter "3.5.2.9 Valve connector identification", page 23
Power consumption	$P_{max} = 9 \text{ W}$ (at $I = 600 \text{ mA}$ and $R = 25 \Omega$)

Electrical data

Table 18: Electrical data

4.5 Emissions

WARNING



The magnets in the permanent magnet linear force motor create strong magnetic fields, which can have a disruptive effect on sensitive devices, such as e.g., cardiac pacemakers. The relevant safe distances appropriate for the device must be observed.

CAUTION



Depending on the application, significant levels of noise may be generated when the valves are operated. If necessary, the manufacturer and operator of the machine must take appropriate sound insulation measures or stipulate that suitable safety equipment, such as e.g., ear protection, be worn.

Environmental protection: Emissions

Generally speaking, the valves do not generate harmful emissions when they are used for their intended purpose.

For your notes.

5 Characteristic Curves

5.1 Dependency of flow and pressure drop

The flow that is set depends not only on the spool position but also on the pressure difference Δp at the individual control lands.

A command signal of 100 % produces with a rated pressure difference of $\Delta p_N = 35$ bar (508 psi) per control land the rated flow Q_N . If the pressure difference is altered, the flow Q also changes with a constant command signal in accordance with the following formula:

$$Q = Q_N \cdot \sqrt{\frac{\Delta p}{\Delta p_N}}$$

Q [l/min (gpm)] : actual flow

Q_N [l/min (gpm)] : rated flow

Δp [bar (psi)] : actual pressure difference per control land

Δp_N [bar (psi)] : rated pressure difference

$\Delta p_N = 35$ bar (508 psi) per control land

- ⓘ To avoid cavitation, the flow speed of the actual flow Q calculated in this way at ports (A, B, P, T, etc.) must not be too great.
In typical applications the maximum permissible flow speed is 30 m/s (approx. 100 ft/s).

⇒ Chapter "3.3.1 Open-loop flow control (Q-control)", page 16

Formula for calculating the flow Q

5.2 Flow signal characteristic curve ¹

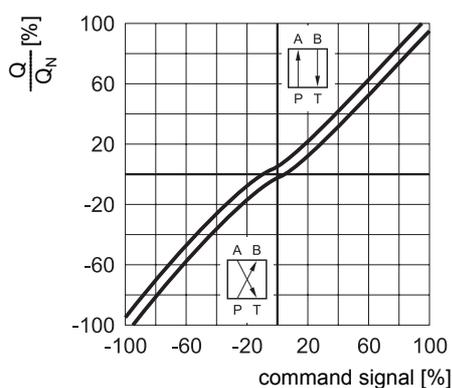


Figure 8: Flow signal characteristic curve

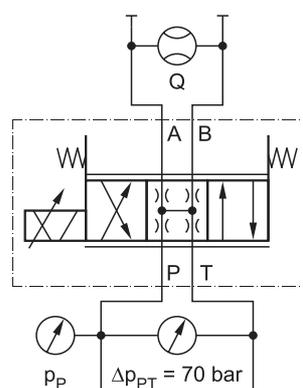


Figure 9: Setup for measuring the flow signal characteristic curve

Flow signal characteristic curve

¹ Typical characteristic curves (measured at operating pressure $p_P = 140$ bar (2,030 psi), viscosity of hydraulic fluid $\nu = 32$ mm²/s and temperature of hydraulic fluid $T = 40$ °C (104 °F))

5.3 Spool stroke signal characteristic curve ¹

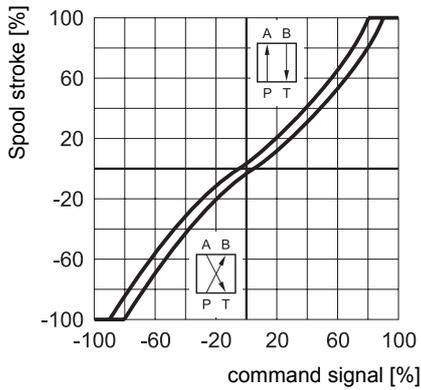


Figure 10: Spool stroke signal characteristic curve

Spool stroke signal characteristic curve

5.4 Pressure signal characteristic curve ¹

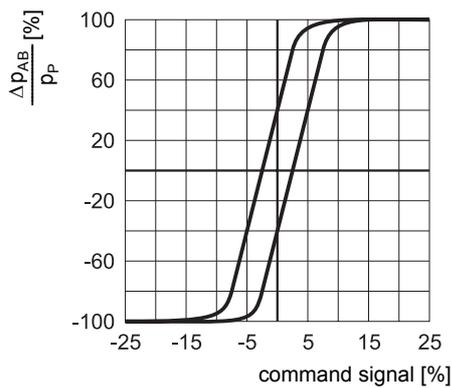


Figure 11: Pressure signal characteristic curve of the valves with zero lap

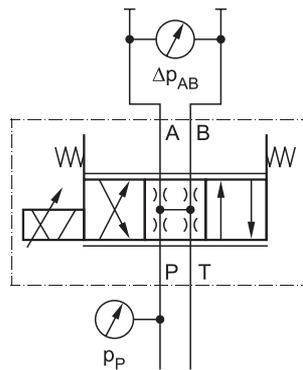
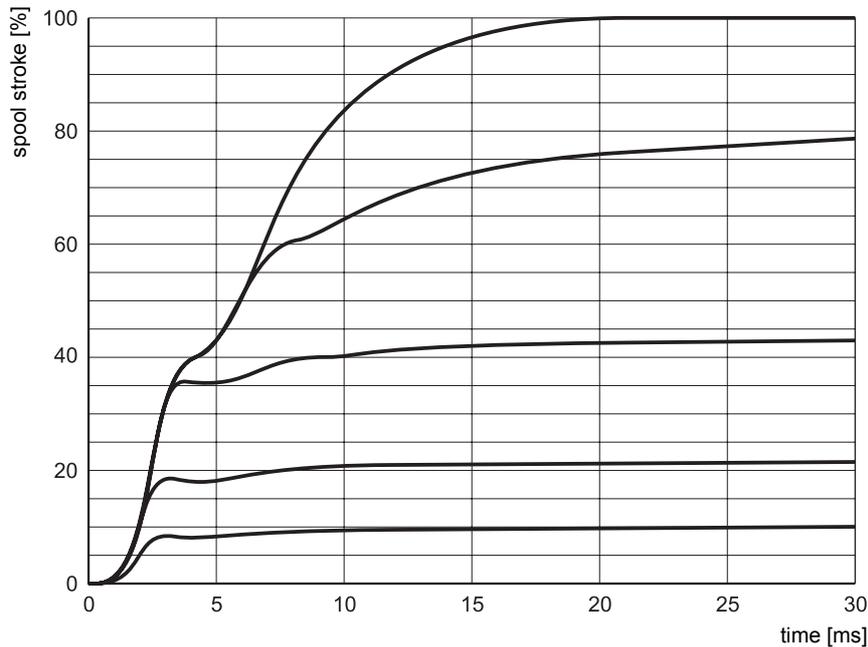


Figure 12: Setup for measuring the pressure signal characteristic curve

Pressure signal characteristic curve of the valves with zero lap

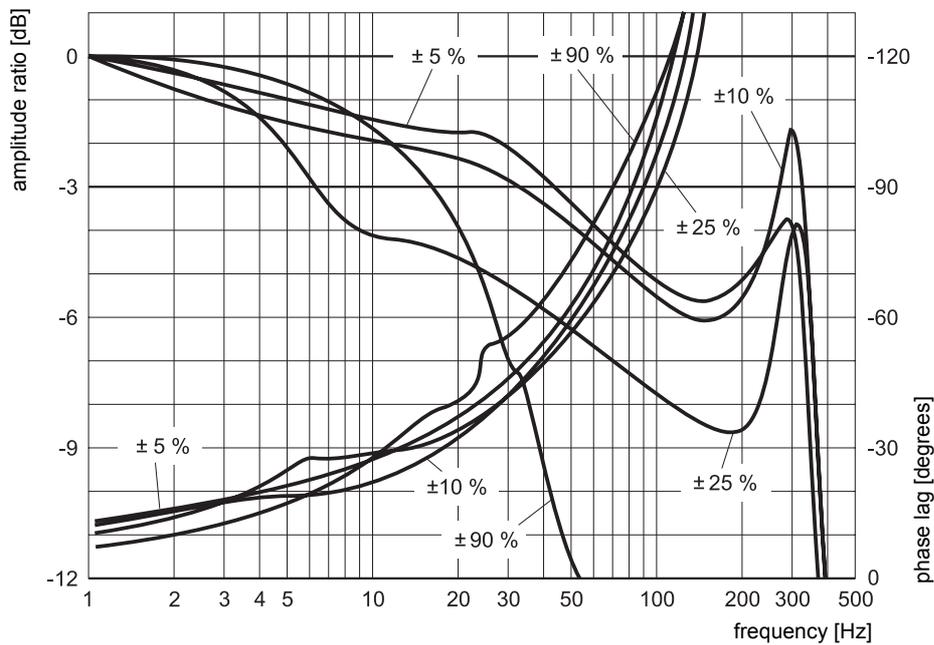
¹ Typical characteristic curves (measured at operating pressure $p_P = 140$ bar (2,030 psi), viscosity of hydraulic fluid $\nu = 32$ mm²/s and temperature of hydraulic fluid $T = 40$ °C (104 °F))

5.5 Step response and frequency response ¹



Step response of the spool stroke

Figure 13: Step response of the spool stroke



Frequency response of the spool stroke

Figure 14: Frequency response of the spool stroke

¹ Typical characteristic curves (measured with Mini DDV Amplifier G123-821 at 24 V, operating pressure $p_P = 140$ bar (2,030 psi), viscosity of hydraulic fluid $\nu = 32$ mm²/s and temperature of hydraulic fluid $T = 40$ °C (104 °F))

For your notes.

6 Transportation and Storage

WARNING



The permissible ambient conditions for the valves must be maintained at all times including transportation and storage.

⇒ [Chapter "4 Technical Data", page 25](#)

The valves must be protected in particular to prevent entry of dust and moisture.

Fault-free, reliable and safe operation cannot be guaranteed if the above requirements are not observed.

**Safety instructions:
Transportation and
storage**

WARNING



The valves must not be transported or stored without their shipping plate mounted.

This is the only way of adequately protecting the valves against the ingress of dirt and moisture and protecting the seals against the effects of ozone and UV.

CAUTION



To provide protection against injuries or other damaging influences on health, suitable protective measures must be taken if necessary prior to and when carrying out any work on the valves or the machine, such as e.g., mounting or removing, electrical or hydraulic connection, troubleshooting or servicing, and when handling the valves, accessories, tools or hydraulic fluids.

⇒ [Chapter "2.6 Occupational safety and health", page 9](#)

CAUTION



The valve shipping plate may only be removed from the valve hydraulic ports directly prior to mounting and must be re-mounted directly after the valve has been removed. This is the only way of adequately protecting the valves against the ingress of dirt and moisture and protecting the seals against the effects of ozone and UV.

The shipping plate and the associated fastening elements (screws and nuts) must be kept for later use, e.g., during transportation.

CAUTION



Do not misuse the connectors, mating connectors (plugs) and connection cables of the valves, e.g., as a tread or transport fixture.

CAUTION



To avoid condensation after the valves have been transported or stored, wait until they have reached the ambient temperature before starting up the valves.

CAUTION



To avoid damage, always transport or store valves, spare parts and accessories only in the properly sealed original packaging. Warranty and liability claims for personal injury and damage to property are excluded if they are caused by valves, spare parts or accessories having been stored or transported outside their original packaging.

⇒ [Chapter "1.5 Warranty and liability", page 4](#)

CAUTION

After transporting or storing valves, spare parts and accessories, check the original packaging and contents for possible damage.

Do not start up the system if the packaging or contents show signs of damage. In this case, immediately notify us or the responsible supplier.

In the event of transportation damage, store the damaged packaging so that if necessary damages can be claimed from the transport contractor.

6.1 Unpacking/checking a delivery

Procedure:

1. Check whether the packaging is damaged.
2. Remove the packaging.
3. Store the damaged packaging so that if necessary damages can be claimed from the transport contractor.
We recommend that you also keep the undamaged original packaging for later transportation or storage operations.
4. Dispose of the packaging material no longer needed in accordance with the relevant national waste disposal regulations and environmental protection provisions.
5. Check whether the packaging contents is damaged.
6. In the event of damaged packaging or damaged contents, immediately notify us or the responsible supplier.
7. Check whether the delivery corresponds to the order and the delivery note.
8. In the event of wrong or incomplete delivery, immediately notify us or the responsible supplier.

Unpacking/checking a delivery

6.2 Scope of delivery of the valve

The scope of delivery of the valve consists of:

- Valve with mounted oilproof shipping plate at the hydraulic port
- 4 O-rings ID 9.25 x Ø 1.8 [mm] (ID 0.364 x Ø 0.071 [in]) for ports A, B, P and T
- 1 O-ring ID 7.65 x Ø 1.8 [mm] (ID 0.301 x Ø 0.071 [in]) for port Y

Scope of delivery of the valve

6.3 Storage

The following effects may occur in the course of long-term storage:

- Sealing materials become brittle, possibly resulting in leaks
- Hydraulic fluid becomes gummy, possibly resulting in friction

In order to avoid possible resulting impairments or damage, we recommend that the valve, after a period of storage or operation of more than 5 years, be inspected by us or one of our authorized service centers.

Effects of long-term storage

7 Mounting and Connection to the Hydraulic System

DANGER



During operation, do not carry out any work, such as e.g., mounting or removal, electrical or hydraulic connection, troubleshooting or servicing, on the valves or the machine.

Failure to comply with this requirement results in danger due to:

- Hydraulic fluid squirting out under pressure
- Uncontrolled sequences of motions
- Destruction
- Malfunction

Before working on the valves or the machine, shut down and switch off the machine without fail and de-energize and depressurize the machine.

For this purpose, switch off the command signal of the valves as well as the supply voltage of the connected peripherals, such as e.g., externally powered transducers or programming units.

Secure the machine without fail against restarting.

Examples of suitable securing measures:

- Lock the main command device and remove the key
- Attach a warning sign to the master switch

**Safety instructions:
Mounting and Connection
to the Hydraulic System**

DANGER



Hydraulic fluid squirting out under high pressure can cause serious personal injuries, burns and fires.

Depressurize all hydraulic lines and accumulators in the hydraulic circuit before mounting or removing, electrical or hydraulic connection, start-up, troubleshooting or servicing.

WARNING



Only properly qualified and authorized users may work with and on the valves.

⇒ [Chapter "2.4 Selection and qualification of personnel", page 8](#)

CAUTION

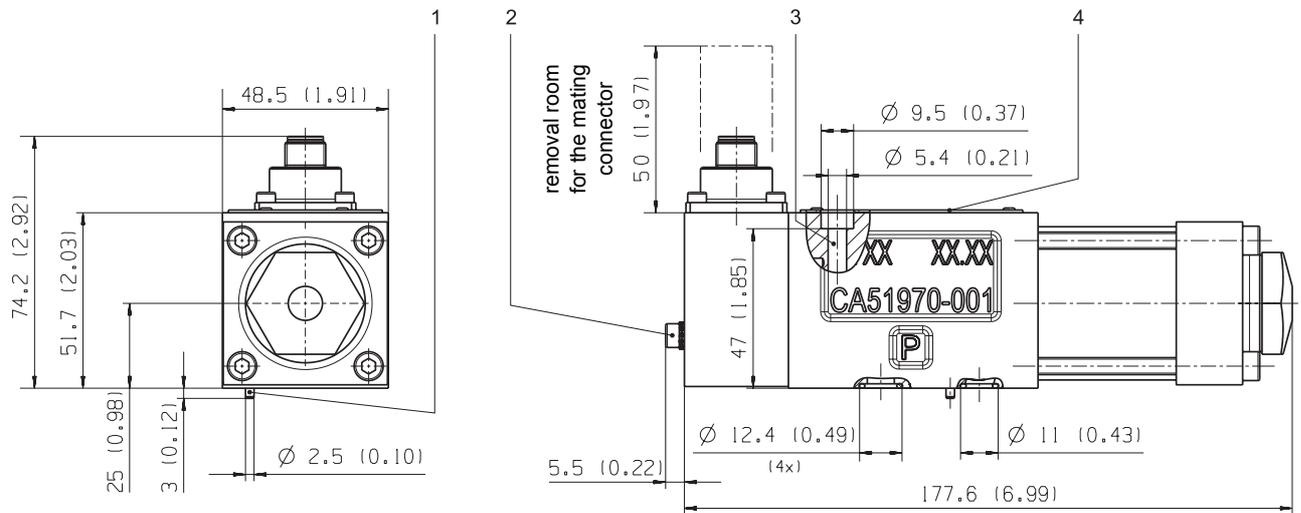


To provide protection against injuries or other damaging influences on health, suitable protective measures must be taken if necessary prior to and when carrying out any work on the valves or the machine, such as e.g., mounting or removing, electrical or hydraulic connection, troubleshooting or servicing, and when handling the valves, accessories, tools or hydraulic fluids.

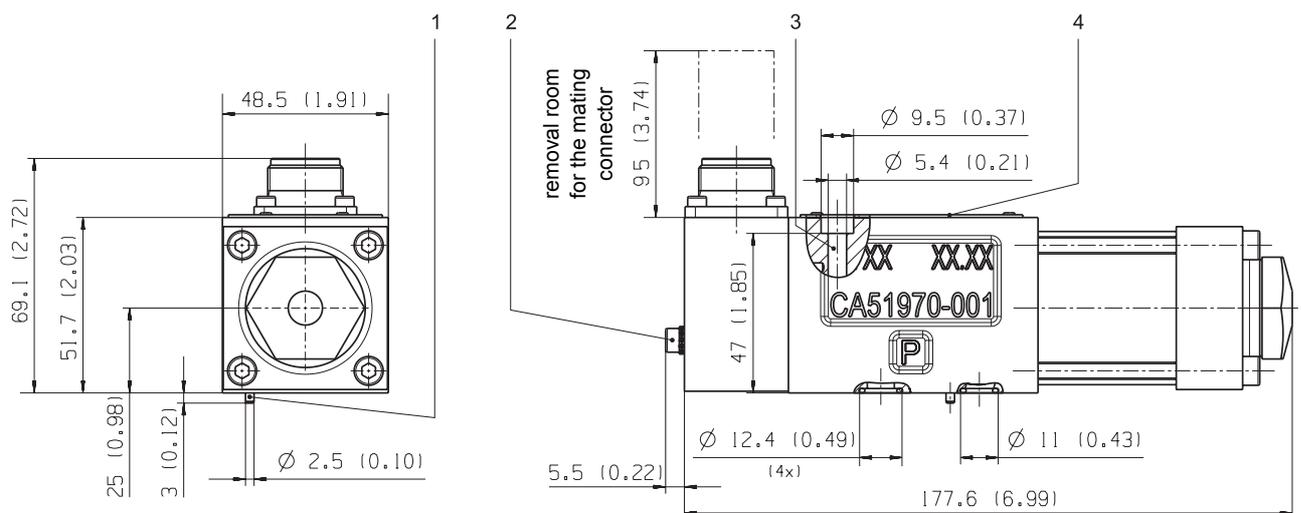
⇒ [Chapter "2.6 Occupational safety and health", page 9](#)

7.1 Dimensions (installation drawings)

Valves with M12 connector:



Valves with MIL connector:



Item	Designation	Further information
1	Positioning pin	⇒ Chapter "7.3 Mounting the valves", page 38
2	Grounding screw	⇒ Chapter "8.3 Grounding screw", page 44
3	Installation screw or attachment screw of the shipping plate	⇒ Chapter "7.3.2 Specification for installation screws", page 38 ⇒ Chapter "7.2.2 Mounting pattern of mounting surface", page 37
4	Nameplate	⇒ Chapter "3.5 Nameplate", page 18

Figure 15: Installation drawings for valves with M12 or MIL valve connector, dimensions in mm (inches)

Hydraulic symbols: ⇒ Chapter "3.3.2 Valve configurations and hydraulic symbols", page 16

Procedure for mounting the valve: ⇒ Chapter "7.3.3 Procedure", page 39

Position of the ports: ⇒ Chapter "7.2.2 Mounting pattern of mounting surface", page 37

Pin assignment of X1: ⇒ Chapter "8.2 Valve connector X1", page 43

7.2 Mounting surface

- ⓘ If the valve is mounted on the mounting surface, it projects over the mounting surface.

Valve dimensions:

⇒ Chapter "7.1 Dimensions (installation drawings)", page 36

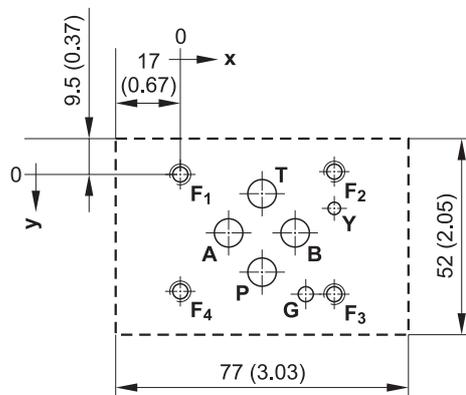
7.2.1 Surface quality

Evenness as per DIN EN ISO 1302: < 0.01 mm (0.00039 in)
over 100 mm (3.94 in)

Average surface finish R_a as per DIN EN ISO 1302: < 0.8 μm (0.000030 in)

**Evenness and roughness
of the mounting surface**

7.2.2 Mounting pattern of mounting surface



**Mounting pattern of
mounting surface**

	P	A	T	B	F ₁	F ₂	F ₃	F ₄	X ¹	Y	G ²
	Ø 7.5 (0.30)	Ø 7.5 (0.30)	Ø 7.5 (0.30)	Ø 7.5 (0.30)	M5	M5	M5	M5	-	Ø 3.3 (0.13)	Ø 4.0 (0.16)
x	21.5 (0.85)	12.7 (0.50)	21.5 (0.85)	30.2 (1.19)	0	40.5 (1.59)	40.5 (1.59)	0	-	40.5 (1.59)	33 (1.30)
y	25.9 (1.02)	15.5 (0.61)	5.1 (0.20)	15.5 (0.61)	0	-0.75 (-0.03)	31.75 (1.25)	31 (1.22)	-	9.0 (0.35)	31.75 (1.25)

Figure 16: Mounting pattern of mounting surface as per ISO 4401-03-03-0-05, dimensions in mm (inches)

¹ Do not drill port X as the port is not sealed on the valve side

² Bore G for positioning pin must be at least 4 mm (0.16 in) deep

7.3 Mounting the valves

7.3.1 Tools and materials required

The following tools and materials are required for mounting the valves:

- Flat-bladed screwdriver 8x1.6 [mm] and if necessary open-end wrench WAF 8 (for removing the shipping plate)
- Torque wrench for hexagon socket head cap screws WAF 4 (for mounting the valve)
- Installation screws
⇒ Chapter "7.3.2 Specification for installation screws", page 38
- If necessary, replacement for port O-rings to be replaced
⇒ Chapter "13.2 Spare parts", page 66

- i** The installation screws and replacement O-rings are not included in the valves' scope of delivery. They are available as accessories.
⇒ Chapter "13.1 Accessories", page 65

Tools and materials required for mounting the valves

7.3.2 Specification for installation screws

Hexagon socket head cap screws as per DIN EN ISO 4762	Quality class	Number required	Tightening torque
M5x55	10.9	4	6.8 Nm (5.0 lbf ft) ± 10 %

Specification for installation screws

Table 19: Specification for installation screws

7.3.3 Procedure

WARNING



Use the installation screws specified here for mounting the valve. The shipping plate attachment screws must not under any circumstances be used to mount the valve. Secure valve mounting cannot be guaranteed in such a case.
Specification for installation screws: ⇒ [Table 19, page 38](#)

**Safety instructions:
Mounting the valves**

CAUTION



The valve shipping plate may only be removed from the valve hydraulic ports directly prior to mounting and must be re-mounted directly after the valve has been removed. This is the only way of adequately protecting the valves against the ingress of dirt and moisture and protecting the seals against the effects of ozone and UV.

The shipping plate and the associated fastening elements (screws and nuts) must be kept for later use, e.g., during transportation.

CAUTION



To prevent the valve from overheating, mount the valve so as to ensure adequate ventilation.

Do not mount the valve directly on machine parts which are exposed to strong vibrations or sudden movement.

On units that are moved in jerks and jolts, the movement direction of the spool should not be the same as the movement direction of the unit.

CAUTION



The valve connecting surface and the mounting surface must be free of residues and dirt when the valve is about to be mounted.

Use a clean, soft and fluff-free cloth to clean the connecting and mounting surfaces. Do not use cleaning wool. Do not use any cleaning agents or methods which could attack the surfaces or the O-rings mechanically or chemically.

Procedure:

1. Clean the valve connecting surface and the mounting surface.
Check and if necessary correct the evenness and roughness of the mounting surface.
⇒ [Chapter "7.2.1 Surface quality", page 37](#)
2. Remove the shipping plate from the valve's hydraulic port.
The shipping plate and the associated fastening elements (screws and nuts) must be kept for later use, e.g., during transportation.
3. Check for presence, elasticity, integrity and correct seating of the O-rings in the valve ports (A, B, P, T, etc.).
If necessary, install O-rings, replace or correct the seating.
4. Paying attention to the positioning pin, place the valve on the mounting surface and align with the mounting bores.
5. Secure the valve. To do so, tighten the installation screws (hexagon socket head cap screws) free from distortion in diagonal sequence.
Tightening torque: 6.8 Nm (5.0 lbf ft) ± 10 %
⇒ [Chapter "7.3.2 Specification for installation screws", page 38](#)

Procedure for mounting the valves

For your notes.

8 Electrical Connection

DANGER



During operation, do not carry out any work, such as e.g., mounting or removal, electrical or hydraulic connection, troubleshooting or servicing, on the valves or the machine.

Failure to comply with this requirement results in danger due to:

- Hydraulic fluid squirting out under pressure
- Uncontrolled sequences of motions
- Destruction
- Malfunction

Before working on the valves or the machine, shut down and switch off the machine without fail and de-energize and depressurize the machine.

For this purpose, switch off the command signal of the valves as well as the supply voltage of the connected peripherals, such as e.g., externally powered transducers or programming units.

Secure the machine without fail against restarting.

Examples of suitable securing measures:

- Lock the main command device and remove the key
- Attach a warning sign to the master switch

**Safety instructions:
Electrical Connection**

DANGER



Hydraulic fluid squirting out under high pressure can cause serious personal injuries, burns and fires.

Depressurize all hydraulic lines and accumulators in the hydraulic circuit before mounting or removing, electrical or hydraulic connection, start-up, troubleshooting or servicing.

WARNING



Only properly qualified and authorized users may work with and on the valves.

⇒ [Chapter "2.4 Selection and qualification of personnel", page 8](#)

WARNING



Touching electrically live parts exposes the user/operator to the risk of:

- Electric shock
- Uncontrolled sequences of motions
- Destruction
- Malfunction

Touching electrically live parts must therefore be avoided!

CAUTION



To provide protection against injuries or other damaging influences on health, suitable protective measures must be taken if necessary prior to and when carrying out any work on the valves or the machine, such as e.g., mounting or removing, electrical or hydraulic connection, troubleshooting or servicing, and when handling the valves, accessories, tools or hydraulic fluids.

⇒ [Chapter "2.6 Occupational safety and health", page 9](#)

- CAUTION**  Do not misuse the connectors, mating connectors (plugs) and connection cables of the valves, e.g., as a tread or transport fixture.
- CAUTION**  Do not lay valve connection cables in the immediate vicinity of high-voltage cables or together with cables that switch inductive or capacitive loads.
- CAUTION**  The insulation materials employed are designed for use in the safety extra-low-voltage range.
To comply with safety regulations requires isolation from the mains as per [EN 61558-1](#) and [EN 61558-2-6](#) and limiting all voltages as per [EN 60204-1](#).
We recommend using SELV/PELV power supplies for the external valve controller.
Electrical connections must be conducted in compliance with EMC requirements.
- CAUTION**  Dirt or moisture can get into the valve through open connectors, i.e., if no mating connector is attached, which may result in damage to the valve.
Open connectors must be covered and sealed.

8.1 Wiring

8.1.1 Tools and materials required

The following are required for electrically connecting the valves:

- Mating connector of valve connector X1 (4-pin, M12 or MIL depending on model)
- Connection cables for mating connector for M12 connector as per [IEC 60947-4-2](#): usable cable with min. Ø 4 mm (0.16 in) and max. Ø 6 mm (0.24 in)
for MIL connector as per [MIL-DTL-5015/14S-2P](#): usable cable with min. Ø 6.5 mm (0.26 in) and max. Ø 9.5 mm (0.37 in)

-  The above-mentioned connectors and cables are not included in the valves' scope of delivery.
The mating connectors are available as accessories.
⇒ [Chapter "13 Accessories and Spare Parts", page 65](#)

Tools and materials required for electrically connecting the valves

8.1.2 Electrical connection of the valves

Procedure:

1. Conduct electrical connection in accordance with the pin assignment.
⇒ [Chapter "8.2 Valve connector X1", page 43](#)
2. Establish equipotential bonding, protective grounding and shielding as per "TN 353" and "TN 494".

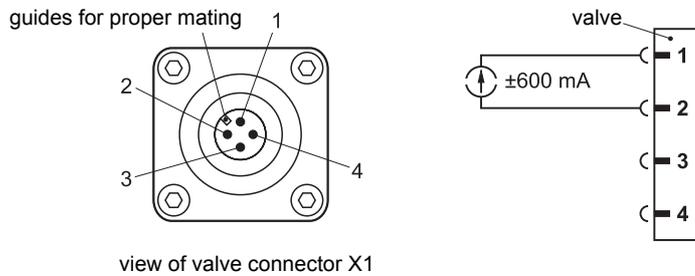
Procedure for electrically connecting the valves

8.2 Valve connector X1

i The mating connector of valve connector X1 is available as accessories.
 ⇒ Chapter "13.1 Accessories", page 65

Mating connector of valve connector X1

8.2.1 M12 valve connector X1



M12 valve connector X1

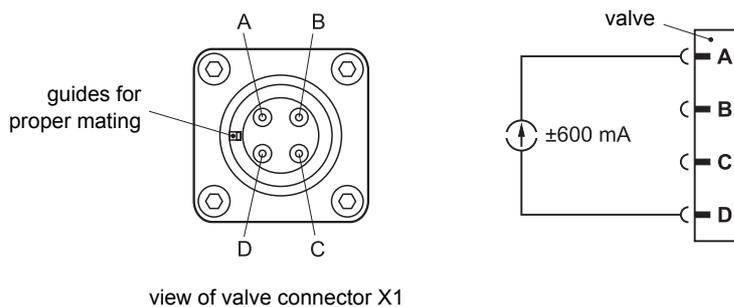
Pin	Assignment	Description
1	Command signal	$I_{in} = \pm 600 \text{ mA}$ $R_{in} = 16 \Omega$ at coil temperature $T = 20 \text{ }^\circ\text{C}$ ($68 \text{ }^\circ\text{F}$)
2	Reference point for the command signal	
3	Not assigned	
4	Not assigned	

Figure 17: M12 valve connector X1 (circuit and pin assignment)

CAUTION To prevent the connector from being damaged, pay attention to the alignment of the guides for proper mating.



8.2.2 MIL valve connector X1



MIL valve connector X1

Pin	Assignment	Description
A	Command signal	$I_{in} = \pm 600 \text{ mA}$ $R_{in} = 16 \Omega$ at coil temperature $T = 20 \text{ }^\circ\text{C}$ ($68 \text{ }^\circ\text{F}$)
B	Not assigned	
C	Not assigned	
D	Reference point for the command signal	

Figure 18: MIL valve connector X1 (circuit and pin assignment)

8.3 Grounding screw

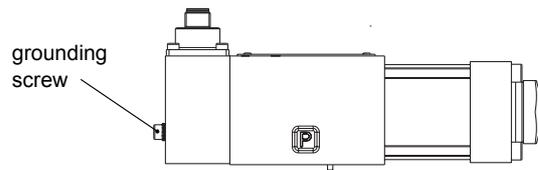


Figure 19: Grounding screw

Grounding screw

The valve is controlled via a shielded connection cable.

If the equipotential bonding current flowing over the shield of the connection cable is too high, this may interfere with the valve or the external valve controller. The interference can be reduced by connecting the grounding screw with the equipotential bonding of the system.

9 Start-up

DANGER



During operation, do not carry out any work, such as e.g., mounting or removal, electrical or hydraulic connection, troubleshooting or servicing, on the valves or the machine.

Failure to comply with this requirement results in danger due to:

- Hydraulic fluid squirting out under pressure
- Uncontrolled sequences of motions
- Destruction
- Malfunction

Before working on the valves or the machine, shut down and switch off the machine without fail and de-energize and depressurize the machine.

For this purpose, switch off the command signal of the valves as well as the supply voltage of the connected peripherals, such as e.g., externally powered transducers or programming units.

Secure the machine without fail against restarting.

Examples of suitable securing measures:

- Lock the main command device and remove the key
- Attach a warning sign to the master switch

**Safety instructions:
Start-up**

DANGER



Operating machines with damaged or defective components or with a leaking hydraulic system is dangerous and not permitted.

Before starting up or operating the valve, check the higher-level machine including all of its installed components for damage and defects.

Pay particular attention here to higher-level and hydraulic safety devices, such as e.g., EMERGENCY STOP switches and pressure-limiting valves.

In addition, to avoid damage or leaks, perform the following tasks at regular intervals in accordance with the instructions of the manufacturer and the operator of the machine:

- Checking the valve and the hydraulic system for externally identifiable damage and defects.
- Checking for loose plugs/connectors.
- Checking the cleanliness level of the hydraulic fluid.
- Checking the port O-rings for elasticity, integrity and correct seating.
⇒ Chapter "11.2.1 Checking and replacing the port O-rings", page 58

Report damage or defects to the relevant department immediately. If necessary, shut down and secure the machine immediately. Rectify any leaks immediately in accordance with this user manual, paying particular attention to the notes/instructions on handling in accordance with safety requirements.

⇒ Chapter "2.2 Handling in accordance with safety requirements", page 6

⇒ Chapter "11.3 Troubleshooting", page 59

DANGER

Hydraulic fluid squirting out under high pressure can cause serious personal injuries, burns and fires.

Depressurize all hydraulic lines and accumulators in the hydraulic circuit before mounting or removing, electrical or hydraulic connection, start-up, troubleshooting or servicing.

WARNING

Only properly qualified and authorized users may work with and on the valves.

⇒ Chapter "2.4 Selection and qualification of personnel", page 8

WARNING

Excessive pressure at the hydraulic ports damages the valve and can cause unsafe states in the machine and personal injury.

Pressure-limiting valves, for example, or other comparable safety devices must be installed to limit the pressure at all of the hydraulic ports to the specified maximum operating pressure.

Maximum operating pressure:

⇒ Chapter "4 Technical Data", page 25

WARNING

Prior to start-up, the valves must be checked for correct mechanical design. Wrong mechanical design of the valves will result in danger due to:

- Uncontrolled sequences of motions
- Destruction
- Malfunction

CAUTION

The valve shipping plate may only be removed from the valve hydraulic ports directly prior to mounting and must be re-mounted directly after the valve has been removed. This is the only way of adequately protecting the valves against the ingress of dirt and moisture and protecting the seals against the effects of ozone and UV.

The shipping plate and the associated fastening elements (screws and nuts) must be kept for later use, e.g., during transportation.

CAUTION

Do not misuse the connectors, mating connectors (plugs) and connection cables of the valves, e.g., as a tread or transport fixture.

CAUTION

Dirt or moisture can get into the valve through open connectors, i.e., if no mating connector is attached, which may result in damage to the valve.

Open connectors must be covered and sealed.

CAUTION

To provide protection against injuries or other damaging influences on health, suitable protective measures must be taken if necessary prior to and when carrying out any work on the valves or the machine, such as e.g., mounting or removing, electrical or hydraulic connection, troubleshooting or servicing, and when handling the valves, accessories, tools or hydraulic fluids.

⇒ Chapter "2.6 Occupational safety and health", page 9

9.1 Preparations

The valves may only be started up when the following is ensured:

- The higher-level machine with all of its installed components complies with the latest versions of the relevant national and international regulations, standards and guidelines (such as e.g., the EU Machinery Directive, the regulations of the trade association and of TÜV or VDE).
- The valves and all of the other installed components are in a technically fault-free and operationally reliable state.
- No signals which can lead to uncontrolled movements in the machine are transmitted to the valves.

⇒ Chapter "2.1 Intended operation", page 5

Preparations for start-up

9.2 Start-up of the valves

Procedure:

1. Make sure that all of the machine components, connections and ports conform to the specifications of the machine manufacturer and operator.
2. Prepare the hydraulic system.
⇒ Chapter "9.3 Filling and flushing the hydraulic system", page 48
3. Establish the valve hydraulic connection.
⇒ Chapter "7.3 Mounting the valves", page 38
4. Establish the valve electrical connection.
⇒ Chapter "8 Electrical Connection", page 41
5. Make sure that all of the mechanical, electrical and hydraulic connections are correctly established.
6. Start-up of the hydraulic system.
⇒ Chapter "9.4 Start-up of the hydraulic system", page 49

Procedure for start-up

9.3 Filling and flushing the hydraulic system

WARNING



If a switching valve is fitted to flush the hydraulic system, this must not cause any potentially dangerous states in the machine.

Procedure:

1. Depressurize the hydraulic system.
2. Fill the hydraulic system in accordance with the instructions of the manufacturer and the operator of the machine.
Because new hydraulic fluid is contaminated, the hydraulic system must be filled via a filling filter with a filter fineness of at least $\beta_{10} \geq 75$ (10 μm (0.00039 in) absolute).
3. Replace existing filter elements with flushing elements in accordance with the instructions of the manufacturer and the operator of the machine.
4. Remove the servovalve.
⇒ [Chapter "11.1 Removing the valves", page 57](#)
5. Instead of the servovalve, you must install a flushing plate or, if allowed by the hydraulic system, a switching valve.
 - ⓘ Use the flushing plate to flush lines P and T.
The switching valve can also be used to flush the actuator with lines A and B.
 - ⓘ The flushing plates are not included in the valves' scope of delivery. They are available as accessories.
⇒ [Chapter "13.1 Accessories", page 65](#)
6. Carefully flush the hydraulic system in accordance with the instructions of the manufacturer and the operator of the machine. Observe the following when doing so:
 - In order to obtain the best possible flushing effect, make sure the hydraulic fluid reaches operating temperature.
 - Observe the minimum flushing time t:

$$t = 5 \cdot \frac{V}{Q} \quad [\text{h}]$$
 - V [l] : tank capacity
 - Q [l/min] : pump delivery
 - End the flushing process when at least the cleanliness level 18/15/12 as specified in [ISO 4406](#) is achieved.
7. Depressurize the hydraulic system.
8. Replace flushing elements with suitable filter elements in accordance with the instructions of the manufacturer and the operator of the machine.
9. Remove the flushing plate or switching valve.
10. Mount the servovalve.
⇒ [Chapter "7.3 Mounting the valves", page 38](#)

Procedure for filling and flushing the hydraulic system

9.4 Start-up of the hydraulic system

Procedure:

1. Start up the hydraulic system in accordance with the instructions of the manufacturer and the operator of the machine.
2. Vent the hydraulic system in accordance with the instructions of the manufacturer and the operator of the machine.
3. Check the hydraulic system for external leaks.

Procedure for start-up of the hydraulic system

9.4.1 Venting the hydraulic system

CAUTION



Air trapped in the hydraulic system, particularly in the case of high pressure peaks in the system, can cause a diesel effect. If the trapped air bubbles are compressed very quickly and thus heated, this can cause the mixture to self-ignite. This causes a very high increase in pressure and temperature locally, which in turn can result in damage in the hydraulic system, e.g., to seals or components, causing the oil to age more quickly. To avoid diesel effects, it is essential to vent the hydraulic system.

For your notes.

10 Operation

DANGER



During operation, do not carry out any work, such as e.g., mounting or removal, electrical or hydraulic connection, troubleshooting or servicing, on the valves or the machine.

Failure to comply with this requirement results in danger due to:

- Hydraulic fluid squirting out under pressure
- Uncontrolled sequences of motions
- Destruction
- Malfunction

Before working on the valves or the machine, shut down and switch off the machine without fail and de-energize and depressurize the machine.

For this purpose, switch off the command signal of the valves as well as the supply voltage of the connected peripherals, such as e.g., externally powered transducers or programming units.

Secure the machine without fail against restarting.

Examples of suitable securing measures:

- Lock the main command device and remove the key
- Attach a warning sign to the master switch

**Safety instructions:
Operation**

DANGER



Operating machines with damaged or defective components or with a leaking hydraulic system is dangerous and not permitted.

Before starting up or operating the valve, check the higher-level machine including all of its installed components for damage and defects.

Pay particular attention here to higher-level and hydraulic safety devices, such as e.g., EMERGENCY STOP switches and pressure-limiting valves.

In addition, to avoid damage or leaks, perform the following tasks at regular intervals in accordance with the instructions of the manufacturer and the operator of the machine:

- Checking the valve and the hydraulic system for externally identifiable damage and defects.
- Checking for loose plugs/connectors.
- Checking the cleanliness level of the hydraulic fluid.
- Checking the port O-rings for elasticity, integrity and correct seating.
⇒ Chapter "11.2.1 Checking and replacing the port O-rings", page 58

Report damage or defects to the relevant department immediately. If necessary, shut down and secure the machine immediately. Rectify any leaks immediately in accordance with this user manual, paying particular attention to the notes/instructions on handling in accordance with safety requirements.

⇒ Chapter "2.2 Handling in accordance with safety requirements", page 6

⇒ Chapter "11.3 Troubleshooting", page 59

WARNING

Only properly qualified and authorized users may work with and on the valves.

⇒ Chapter "2.4 Selection and qualification of personnel", page 8

WARNING

Observe and adhere to the technical data and in particular the information given on the valve nameplate.

⇒ Chapter "4 Technical Data", page 25

WARNING

Prior to start-up, the valves must be checked for correct mechanical design. Wrong mechanical design of the valves will result in danger due to:

- Uncontrolled sequences of motions
- Destruction
- Malfunction

CAUTION

To provide protection against injuries or other damaging influences on health, suitable protective measures must be taken if necessary prior to and when carrying out any work on the valves or the machine, such as e.g., mounting or removing, electrical or hydraulic connection, troubleshooting or servicing, and when handling the valves, accessories, tools or hydraulic fluids.

⇒ Chapter "2.6 Occupational safety and health", page 9

CAUTION

Dirt or moisture can get into the valve through open connectors, i.e., if no mating connector is attached, which may result in damage to the valve.

Open connectors must be covered and sealed.

10.1 Preparations for operation

The valves may only be operated as a component part of a higher-level overall system, for example in a machine.

⇒ Chapter "2.1 Intended operation", page 5

The following must be completed before the valve is operated:

- Qualified project planning
 - Correct start-up and configuration of the valve
- ⇒ Chapter "9 Start-up", page 45

Preparations for valve operation

10.2 Operation of the valve

The valve is controlled via the command signal which it receives from the machine controller.

Direct interventions by the user on the valve during normal operation are not necessary.

The valve has no controls, such as e.g., switches or buttons, which must be actuated.

Information on maintenance:

⇒ [Chapter "11.2 Maintenance", page 58](#)

Information on correcting possible faults:

⇒ [Chapter "11.3 Troubleshooting", page 59](#)

**Operation of the valve:
Via command signal from
the machine controller**

10.3 Shutting down the valve

DANGER



Hydraulic pressure and electrical supply voltage are still normally applied after the valve has been shut down. The machine is not automatically put out of operation when the valve is shut down.

During operation, do not carry out any work, such as e.g., mounting or removal, electrical or hydraulic connection, troubleshooting or servicing, on the valves or the machine.

Failure to comply with this requirement results in danger due to:

- Hydraulic fluid squirting out under pressure
- Uncontrolled sequences of motions
- Destruction
- Malfunction

Before working on the valves or the machine, shut down and switch off the machine without fail and de-energize and depressurize the machine.

For this purpose, switch off the command signal of the valves as well as the supply voltage of the connected peripherals, such as e.g., externally powered transducers or programming units.

Secure the machine without fail against restarting.

Examples of suitable securing measures:

- Lock the main command device and remove the key
- Attach a warning sign to the master switch

**Safety instructions:
Shutting down the valve**

The valve can be shut down by switching off the command signal.

If necessary, the valve can be restarted by switching on the command signal.

⇒ [Chapter "3.2.2 Restarting the valve", page 15](#)

Shutting down the valve

For your notes.

11 Service

DANGER



During operation, do not carry out any work, such as e.g., mounting or removal, electrical or hydraulic connection, troubleshooting or servicing, on the valves or the machine.

Failure to comply with this requirement results in danger due to:

- Hydraulic fluid squirting out under pressure
- Uncontrolled sequences of motions
- Destruction
- Malfunction

Before working on the valves or the machine, shut down and switch off the machine without fail and de-energize and depressurize the machine.

For this purpose, switch off the command signal of the valves as well as the supply voltage of the connected peripherals, such as e.g., externally powered transducers or programming units.

Secure the machine without fail against restarting.

Examples of suitable securing measures:

- Lock the main command device and remove the key
- Attach a warning sign to the master switch

**Safety instructions:
Service**

DANGER



Operating machines with damaged or defective components or with a leaking hydraulic system is dangerous and not permitted.

Before starting up or operating the valve, check the higher-level machine including all of its installed components for damage and defects.

Pay particular attention here to higher-level and hydraulic safety devices, such as e.g., EMERGENCY STOP switches and pressure-limiting valves.

In addition, to avoid damage or leaks, perform the following tasks at regular intervals in accordance with the instructions of the manufacturer and the operator of the machine:

- Checking the valve and the hydraulic system for externally identifiable damage and defects.
- Checking for loose plugs/connectors.
- Checking the cleanliness level of the hydraulic fluid.
- Checking the port O-rings for elasticity, integrity and correct seating.

⇒ Chapter "11.2.1 Checking and replacing the port O-rings", page 58

Report damage or defects to the relevant department immediately. If necessary, shut down and secure the machine immediately. Rectify any leaks immediately in accordance with this user manual, paying particular attention to the notes/instructions on handling in accordance with safety requirements.

⇒ Chapter "2.2 Handling in accordance with safety requirements", page 6

⇒ Chapter "11.3 Troubleshooting", page 59

DANGER

Hydraulic fluid squirting out under high pressure can cause serious personal injuries, burns and fires.

Depressurize all hydraulic lines and accumulators in the hydraulic circuit before mounting or removing, electrical or hydraulic connection, start-up, troubleshooting or servicing.

WARNING

Only properly qualified and authorized users may work with and on the valves.

⇒ [Chapter "2.4 Selection and qualification of personnel", page 8](#)

WARNING

In the interests of avoiding damage to the valves or accessories, repairs/corrective maintenance and other maintenance/servicing work explained in this user manual, on account of the complexity of the internal components of the valves or accessories, may only be carried out by us or by our authorized service centers.

Warranty and liability claims for personal injury and damage to property are excluded among other things if they are caused by unauthorized repairs or other unauthorized interventions.

⇒ [Chapter "1.5 Warranty and liability", page 4](#)

CAUTION

To provide protection against injuries or other damaging influences on health, suitable protective measures must be taken if necessary prior to and when carrying out any work on the valves or the machine, such as e.g., mounting or removing, electrical or hydraulic connection, troubleshooting or servicing, and when handling the valves, accessories, tools or hydraulic fluids.

⇒ [Chapter "2.6 Occupational safety and health", page 9](#)

CAUTION

Unsuitable or defective accessories or unsuitable or defective spare parts may cause damage, malfunctions or failure of the valve or the machine.

We recommend the use of original accessories and original spare parts.

Warranty and liability claims for personal injury and damage to property are among other things excluded if they are caused by the use of unsuitable or defective accessories or unsuitable or defective spare parts.

⇒ [Chapter "1.5 Warranty and liability", page 4](#)

⇒ [Chapter "13 Accessories and Spare Parts", page 65](#)

CAUTION

Do not misuse the connectors, mating connectors (plugs) and connection cables of the valves, e.g., as a tread or transport fixture.

11.1 Removing the valves

11.1.1 Tools and materials required

The following tools and materials are required for removing the valves:

- Torque wrench for hexagon socket head cap screws WAF 4 (for removing and mounting the valve)
- If necessary, replacement for port O-rings to be replaced
⇒ [Chapter "13.2 Spare parts", page 66](#)
- Shipping plate and associated fastening elements
- Flat-bladed screwdriver 8x1.6 [mm] and if necessary open-end wrench WAF 8 (for mounting the shipping plate)

Tools and materials required for removing

11.1.2 Procedure

CAUTION



The valve shipping plate may only be removed from the valve hydraulic ports directly prior to mounting and must be re-mounted directly after the valve has been removed. This is the only way of adequately protecting the valves against the ingress of dirt and moisture and protecting the seals against the effects of ozone and UV.

The shipping plate and the associated fastening elements (screws and nuts) must be kept for later use, e.g., during transportation.

**Safety instructions:
Removing the valves**

Procedure:

1. Shut down and switch off the machine and place in a de-energized and depressurized state.
2. Release the valve's installation screws.
3. Remove the valve from the mounting surface.
4. Check for presence, elasticity, integrity and correct seating of the O-rings in the valve ports (A, B, P, T, etc.).
5. Replace hardened and damaged O-rings with new O-rings.
6. Mount the shipping plate to the valve's hydraulic ports.
Tightening torque of the attachment screws:
approx. 5 Nm (3.7 lbf ft) (hand-tight)
7. If the valve is not to be immediately reused or is to be serviced: Store the valve in its original packaging.
⇒ [Chapter "6 Transportation and Storage", page 33](#)
8. If necessary, block the ports of the hydraulic system to prevent the hydraulic fluid from being contaminated.

Procedure for removing the valve

11.2 Maintenance

Changes in temperature, effects of the hydraulic fluid, such as e.g., pressure peaks, and similar influences can, depending on the application, expose the sealing materials to different levels of wear. This in turn may cause leaks.

In order to avoid possible resulting impairments or damage, we recommend that the valve, after a period of storage or operation of more than 5 years, be inspected by us or one of our authorized service centers.

- ❗ If the valve is exposed to high loads, it may be necessary to reduce the check/inspection interval to suit the application.

Embrittlement of the sealing materials

11.2.1 Checking and replacing the port O-rings

11.2.1.1 Tools and materials required

The following are required for checking and replacing the port O-rings:

- Torque wrench for hexagon socket head cap screws WAF 4 (for removing and mounting the valve)
- If necessary, replacement for port O-rings to be replaced
⇒ [Chapter "13.2 Spare parts", page 66](#)

Tools and materials required for checking and replacing the O-rings

11.2.1.2 Checking and replacing the O-rings

Procedure:

1. Remove the valve.
⇒ [Chapter "11.1 Removing the valves", page 57](#)
2. Check for presence, elasticity, integrity and correct seating of the O-rings in the valve ports (A, B, P, T, etc.).
3. Replace hardened and damaged O-rings with new O-rings.
4. Remount the valve.
⇒ [Chapter "7.3 Mounting the valves", page 38](#)

Procedure for checking and replacing the O-rings

11.3 Troubleshooting

The following faults may occur:

- Leak at the valve connecting surface
⇒ Chapter "11.3.1.1 Leak at the valve connecting surface", page 59
- Leak at the linear force motor screw plug
⇒ Chapter "11.3.1.2 Leak at the linear force motor screw plug", page 59
- No hydraulic response by the valve
⇒ Chapter "11.3.2 No hydraulic response by the valve", page 60
- Instability of the external control loop
⇒ Chapter "11.3.3 Instability of the external control loop", page 60

Possible faults

 If the fault cannot be corrected by means of the measures set out below, please contact us or one of our authorized service centers.

After correcting the fault, if necessary remount and restart the valve.

- ⇒ Chapter "7.3 Mounting the valves", page 38
- ⇒ Chapter "3.2.2 Restarting the valve", page 15

Restarting after correcting the fault

11.3.1 Leaks

11.3.1.1 Leak at the valve connecting surface

Measures:

- Check for presence, elasticity, integrity and correct seating of the O-rings in the valve ports (A, B, P, T, etc.).
If necessary, install O-rings, replace or correct the seating.
- Check the valve's mounting and connecting surfaces, the valve and the hydraulic system for damage, contamination and evenness.
- Check installation screws for secure and correct seating.
Retighten screws if necessary with the torque wrench for WAF 4 hexagon socket head cap screws.
Tightening torque of installation screws: 6.8 Nm (5.0 lbf ft) ± 10 %

Leak at the valve connecting surface

11.3.1.2 Leak at the linear force motor screw plug

WARNING



In the event of a leak at the linear force motor screw plug, have the valve checked by us or one of our authorized service centers.

Measures:

- Check ports P and T for correct connection.
- Check max. pressure in ports T and Y.
The return pressure in T may exceed 50 bar (725 psi) only if port Y is used.

Leak at the linear force motor screw plug

11.3.2 No hydraulic response by the valve

WARNING



Touching electrically live parts exposes the user/operator to the risk of:

- Electric shock
- Uncontrolled sequences of motions
- Destruction
- Malfunction

Touching electrically live parts must therefore be avoided!

Measures:

- Check whether all the machine components, connections and ports conform to the specifications of the machine manufacturer and operator. To do so, on the valves compare the data on the nameplate with the specifications.
- Check whether the hydraulic installation is correct and whether all the hydraulic ports are correctly established.
- Check whether the hydraulic pressure is present.
- Check whether the connector is correctly attached and non-corroded.
- Check whether there is a command signal failure or a faulty electric cable.
- Check whether the desired command signal is applied at the connector.
- Check whether the valve is in the fault state.
If necessary, correct the fault and then restart the valve by switching the command signal off and then on again.

Typical fault causes:

- Control error (e.g., due to the spool sticking, which can be caused for instance by contamination)
- No command signal (e.g., due to open circuit)

No hydraulic response by the valve

11.3.3 Instability of the external control loop

Measures:

- Check whether the external control loop is stable.
If necessary, reduce control loop gain.
- Check whether the signal quality of the command signal is sufficient.
- Check whether the system pressure is stable.
- Check whether the quality and cleanliness level of the hydraulic fluid used conforms to the specifications of the manufacturer and the operator of the machine.
- Check whether the controlled system was modified.

Instability of the external control loop

11.4 Repair

Authentic Moog repairs are performed exclusively by us or our authorized service centers. This is the only way of accessing the latest specifications required for repair work. With these specifications, the original valve performance data can be re-established and the customarily high reliability and long life cycle can be guaranteed even after repairs.



Figure 20: Repair quality seal

Our repair seal is a guarantee that an authentic Moog repair has been performed.

- ⓘ In the event of a repair job for defective valves, we and our authorized service centers reserve the right to perform a repair or, after consultation, alternatively to supply replacement valves with an identical or compatible equipment specification.

11.4.1 Contact persons for repairs

Please refer to the following page on our internet site for contact information relating to our service centers:

<http://www.moog.com/industrial/globallocator>

Authentic Moog repairs

Repair quality seal

**Contact persons
for repairs**

For your notes.

12 Disposal

CAUTION

To provide protection against injuries or other damaging influences on health, suitable protective measures must be taken if necessary prior to and when carrying out any work on the valves or the machine, such as e.g., mounting or removing, electrical or hydraulic connection, troubleshooting or servicing, and when handling the valves, accessories, tools or hydraulic fluids.

⇒ [Chapter "2.6 Occupational safety and health", page 9](#)

It is essential to comply with the relevant national waste disposal regulations and environmental protection provisions when disposing of valves, spare parts or accessories, packaging that is no longer needed, hydraulic fluid or auxiliary materials and substances used for cleaning!

If necessary, the items to be disposed of must be expertly dismantled into individual parts, separated into individual materials and placed in the corresponding waste system or earmarked for recycling.

The valve contains among others the following materials:

- Adhesives and casting compounds
- Parts with electro-plated surfaces
- Permanent-magnet materials
- Hydraulic fluid
- Assorted metals and plastics

**Environmental protection:
Disposal**

For your notes.

13 Accessories and Spare Parts

CAUTION



Unsuitable or defective accessories or unsuitable or defective spare parts may cause damage, malfunctions or failure of the valve or the machine.

We recommend the use of original accessories and original spare parts.

Warranty and liability claims for personal injury and damage to property are among other things excluded if they are caused by the use of unsuitable or defective accessories or unsuitable or defective spare parts.

⇒ Chapter "1.5 Warranty and liability", page 4

13.1 Accessories

i The accessories are not included in the valves' scope of delivery.
⇒ Chapter "6.2 Scope of delivery of the valve", page 34

Item designation	Number required	Description	Order number
Service sealing kit (contains all the O-rings for ports A, B, P, T and Y)	1 1	Kit HNBR 90 Shore Kit FKM 90 Shore	B97215-H630F63 B97215-V630F63
Flushing plate for ports P, T, X, Y	1		B46634-002
Connecting plates			On request
Installation screws	4	M5x55 hexagon socket head cap screw as per DIN EN ISO 4762, quality class: 10.9, tightening torque: 6.8 Nm (5.0 lbf ft) ± 10 %	A03665-050-055
Mating connector (metal), IP65 for M12 valve connector X1	1	As per IEC 60947-4-2, usable cable with min. Ø 4 mm (0.16 in) and max. Ø 6 mm (0.24 in)	B97183-004
for 4-pin MIL valve connector X1	1	As per MIL-DTL-5015/14S-2P, usable cable with min. Ø 6.5 mm (0.26 in) and max. Ø 9.5 mm (0.37 in)	B46744-004
Supplementing documents			
User manual "D633-A series", English	1		CA80942-001
Application notes "Technical Note TN 353", English	1	Protective grounding and electrical shielding of hydraulic valves with integrated electronics	CA58437-001
Application notes "Technical Note TN 353", German	1	Protective grounding and electrical shielding of hydraulic valves with integrated electronics	CA58437-002
Application notes "Technical Note TN 494", English	1	Maximum permissible lengths of electric cables for the connection of hydraulic valves with integrated electronics	CA48851-001
Application notes "Technical Note TN 494", German	1	Maximum permissible lengths of electric cables for the connection of hydraulic valves with integrated electronics	CA48851-002

Table 20: Accessories

i The PDF files of the supplementing documents can be downloaded from the following link:
<http://www.moog.com/Industrial/Literature>

13.2 Spare parts

Item designation	Number required	Description	Order number
O-rings			
for ports A, B, P and T	4	ID 9.25 x Ø 1.8 [mm] HNBR 90 Shore (ID 0.364 x Ø 0.071 [in]) FKM 90 Shore	B97009-013 -42082-013
for port Y	1	ID 7.65 x Ø 1.8 [mm] HNBR 90 Shore (ID 0.301 x Ø 0.071 [in]) FKM 90 Shore	B97009-012 -42082-012
Shipping plate	1		B46035-001
Fastening elements for shipping plate		Do not use to mount the valve!	
Attachment screws	min. 2	M5x55, slotted fillister head screw, tightening torque: approx. 5 Nm (3.7 lbf ft) (hand-tight)	-66119-050-055
Fastening nuts	min. 2	M5, hexagon nut	-66118-050

Table 21: Spare parts

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2-Way operation, see Valve configurations
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 DDV (Direct Drive Valve)
 DIN (Deutsches Institut für Normung e. V.,
 German institute for standardization)
 EMC (electromagnetic compatibility)
 EN (Europa-Norm, European standard)
 EPDM (ethylene propylene diene M-class rubber,
 material for seals, such as O-rings)
 EU (European Union)
 FKM (fluorocarbon rubber,
 material for seals, such as O-rings)
 HNBR (hydrogenated nitrile butadiene rubber,
 material for seals, such as O-rings)
 ID (inner diameter, e.g., on O-rings)
 IEC (International Electrotechnical Commission)
 IP (international protection)
 ISO (International Organization for Standardization)
 MIL (military, e.g., in MIL-STD; military standards, which are
 created by the U.S. Department of Defense)
 NG (Nenngröße, nominal size of the valve)
 PELV (protective extra-low voltage)
 SELV (safety extra-low voltage)
 TN (Technical Note)
 TÜV (Technischer Überwachungsverein,
 German technical inspection agency)
 UV (ultraviolet)
 VDE (Verband der Elektrotechnik Elektronik
 Informationstechnik e. V., German association of
 electrical engineering, electronics and information
 technology)
 VDI (Verein Deutscher Ingenieure e. V.,
 association of German engineers)
 WAF (width across flats for wrenches)

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- Δp_N (rated pressure difference)
- I_{in} (input current)
- n (number)
- ν (viscosity)
- P_{max} (power consumption at maximum flow)
- p (pressure)
- p_N (rated pressure)
- p_P (operating pressure)
- Q (flow)
- Q (pump delivery)
- Q_L (leakage flow)
- Q_{max} (maximum flow)
- Q_N (rated flow)
- R_a (average roughness)
- R_{in} (input resistance)
- T (temperature)
- t (time)
- V (volume)

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VDE (Verband der Elektrotechnik Elektronik

Informationstechnik e. V., German association of electrical engineering, electronics and information technology)

VDI (Verein Deutscher Ingenieure e. V., association of German engineers)

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A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

For your notes.

15 Appendix

15.1 Abbreviations, symbols and identification letters

Abb.	Explanation
β_x	Symbol for filter fineness
Δp	Symbol for pressure difference
Δp_N	Symbol for rated pressure difference
ν	Symbol for viscosity
A	Valve port (control port)
A	Pin of 4-pin MIL valve connector X1
B	Valve port (control port)
B	Pin of 4-pin MIL valve connector X1
C	Pin of 4-pin MIL valve connector X1
D	Fail-safe function D of valve
D	Pin of 4-pin MIL valve connector X1
DDV	D irect D rive V alve
DIN	D eutsches I nstitut für N ormung e. V. (German institute for standardization; http://www.din.de)
EMC	E lectromagnetic C ompatibility
EN	E uropa- N orm (European standard)
EPDM	E thylene propylene d iene M -class rubber (material for seals, such as e.g., O-rings)
EU	E uropean U nion
F	Fail-safe function F of valve
F_{1...F₄}	Bore for installation screws or attachment screws of the shipping plate in the mounting pattern of the valve mounting surface
FKM	Fluorocarbon rubber (material for seals, such as e.g., O-rings)
G	Bore for positioning pin in the mounting pattern of the valve mounting surface
HNBR	H ydrogenated n itrile b utadiene r ubber (material for seals, such as e.g., O-rings)
I_{in}	Symbol for input current
ID	Inner d iameter (e.g., on O-rings)
IEC	International E lectrotechnical C ommission (http://www.iec.ch)
IP	International p rotection (IP code; degree of protection type by enclosure as per DIN EN 60529)
ISO	International O rganization for S tandardization (http://www.iso.org)
M	Fail-safe function M of valve
MIL	M ilitary (e.g., in MIL-STD; military standards, which are created by the U.S. Department of Defense) (http://www.iso.org)
n	Number
NG	N enngröße (nominal size), e.g., 6
P	Valve port (pressure port)
P_{max}	Symbol for power consumption at maximum flow
p	Symbol for pressure
p_N	Symbol for rated pressure
p_P	Symbol for operating pressure
PELV	P rotective e xtra- l ow v oltage

Table 22: Abbreviations, symbols and identification letters

Table 22: Abbreviations, symbols and identification letters (part 1 of 2)

Abb.	Explanation
Q	Symbol for flow
Q	Symbol for delivery of a pump
Q_L	Symbol for leakage flow
Q_{max}	Symbol for maximum flow
Q_N	Symbol for rated flow
R_a	Symbol for average roughness
R_{in}	Symbol for input resistance
SELV	S afety e xtra-low v oltage
T	Symbol for temperature
T	Valve port (tank port)
t	Symbol for time
TN	T echnical N ote
TÜV	T echnischer Ü berwachungs v erein (German technical inspection agency)
UV	U ltraviolet
V	Symbol for volume (such as e.g., tank capacity)
VDI	V erein D eutscher I ngenieure e. V. (association of German engineers; http://www.vdi.de)
VDE	V erband d er E lektrotechnik E lektronik I nformationstechnik e. V. (German association of electrical engineering, electronics and information technology; http://www.vde.de)
WAF	W idth a cross f lats for wrenches
X	Valve port
X1	Designations for the valve connector
Y	Valve port (leakage port)

Table 22: Abbreviations, symbols and identification letters

Table 22: Abbreviations, symbols and identification letters (part 2 of 2)

15.2 Additional literature

15.2.1 Moog publications

Press releases:

<http://www.moog.com/Industrial/News>

Newsletters:

<http://www.moog.com/Industrial/Newsletter>

Articles in technical journals:

<http://www.moog.com/Industrial/Articles>

Presentations and scientific publications:

<http://www.moog.com/Industrial/Papers>

User manuals, TNs, catalogs, and similar:

<http://www.moog.com/Industrial/Literature>

**Additional literature:
Moog publications**

15.3 Quoted standards

15.3.1 DIN

DIN 51524-1

Pressure fluids; Hydraulic oils: HL hydraulic oils; Minimum requirements

DIN 51524-2

Pressure fluids; Hydraulic oils: HLP hydraulic oils; Minimum requirements

DIN 51524-3

Pressure fluids; Hydraulic oils: HVLP hydraulic oils; Minimum requirements

Quoted standards: DIN

15.3.2 DIN EN

DIN EN 563

Safety of machinery – Temperatures of touchable surfaces – Ergonomics data to establish temperature limit values for hot surfaces

DIN EN 982

Safety of machinery – Safety requirements for fluid power systems and their components – Hydraulics

DIN EN 60068-2-6

Environmental testing – Part 2: Tests; Test Fc: Vibration (sinusoidal) (IEC 60068-2-6:1995 + Corrigendum 1995)

DIN EN 60068-2-27

Environmental testing – Part 2: Tests; Test Ea and guidance: Shock (IEC 60068-2-27:1987)

DIN EN 60529

Protection types provided by enclosures (IP code)

DIN EN 175201-804

Detail specification – Circular connectors – Round contacts, size diameter 1.6 mm (0.063 in), threaded coupling

Quoted standards: DIN EN

15.3.3 DIN EN ISO

DIN EN ISO 1302

Geometrical Product Specifications (GPS) – Indication of surface texture in technical product documentation

**Quoted standards:
DIN EN ISO**

DIN EN ISO 4762

Hexagon socket head cap screws

DIN EN ISO 12100

Safety of machinery – Basic concepts, general principles for design

15.3.4 EN

EN 60204

Safety of machinery – Electrical equipment of machines

Quoted standards: EN

EN 61558-1

Safety of power transformers, power supplies, reactors and similar products – Part 1: General requirements and tests

EN 61558-2-6

Safety of power transformers, power supply units and similar – Part 2-6: Particular requirements for safety isolating transformers for general use

15.3.5 IEC

IEC 60947-4-2

Low-voltage switchgear and controlgear – Part 4-2: Contactors and motor-starters – AC semiconductor motor controllers and starters

Quoted standards: IEC

15.3.6 ISO

ISO 4401

Hydraulic fluid power – 4-port directional control valves – Mounting surfaces

Quoted standards: ISO

ISO 4406

Hydraulic fluid power – Fluids – Method for coding level of contamination by solid particles

15.3.7 MIL

MIL-DTL-5015/14S-2P

Connectors, electrical, circular threaded, AN type, general specification

Quoted standards: MIL

15.4 Quoted directives

98/37/EC

Directive 98/37/EC of the European Parliament and Council for alignment of the legal and administrative provisions of the Member States for machinery

Quoted directives



VDI offers numerous directives for downloading:

<http://www.vdi-nachrichten.com/ce-richtlinien/basics/richtlinien.asp>

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